FUEL CELL SYSTEM

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Inventor: KOGAMI TAIJI; SAITO KAZUO; CHISAWA HIROSHI; UENO SANJI
Applicant: TOKYO SHIBAURA ELECTRIC CO
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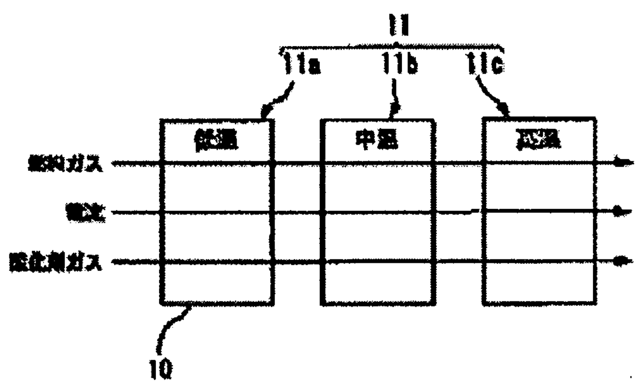
Abstract of **JP11312531**

PROBLEM TO BE SOLVED: To accelerate reaction and increasing the battery cell output by successively relatively raising the operation temperature of cell stacks connected in series in the flow direction of reaction gas, and moistening the reaction gas according to the operating temperature of the cell stack flowing at first, then supplying the moistened reaction gas. SOLUTION: A fuel cell system is constituted with cell stacks 11a, 11b, 11c for operating at low, middle, and high temperatures, fuel gas and oxidizing agent gas let continuously flow from the low temperature side to the high temperature side. The fuel gas and the oxidizing agent gas are previously moistened by adding water vapor, and the temperature of a reaction gas is raised so as to correspond to the operation temperature of each cell stack. Even if the non-reacted part of the reaction gas is increased in the cell stack 11a for operating at low temperature, the non-reacted gas is reacted and completely consumed in the cell stacks 11b, 11c for operating at the intermediate and high temperatures. Even if condensed water generating on a carbon electrode side of the cell stack 11a is increased, the water is evaporated in the cell stacks 11b, 11c, and the reaction of the oxidizing agent gas is conducted smoothly.



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(71)出願人　000003078
株式会社東芝
神奈川県川崎市幸区堀川町72番地

(72)発明者　小上　泰司
神奈川県川崎市川崎区浮島町2番1号　株式会社東芝浜川崎工場内

(72)発明者　齊藤　和夫
神奈川県川崎市川崎区浮島町2番1号　株式会社東芝浜川崎工場内

(72)発明者　知沢　洋
神奈川県川崎市川崎区浮島町2番1号　株式会社東芝浜川崎工場内

(74)代理人　弁理士　波多野　久　（外1名）

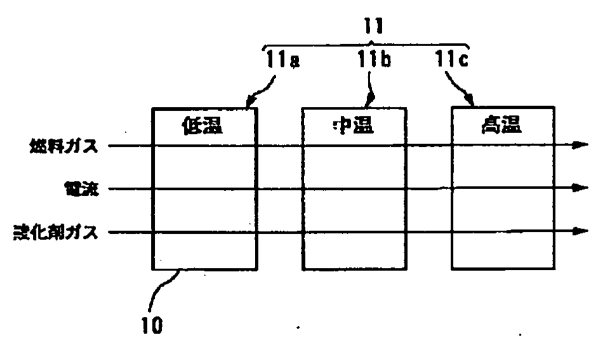
最終頁に続く

(54)【発明の名称】　燃料電池装置

(57)【要約】

【課題】燃料ガスと酸化剤ガスとの反応をより一層促進し、高電池出力化を図った燃料電池装置を提供する。

【解決手段】本発明に係る燃料電池装置は、電池スタック１１をシリーズに接続し、シリーズに接続した電池スタック１１の運転温度を反応ガスの流れ方向に順次相対的に高温化するとともに、反応ガスを最初に流す電池スタック１１の運転温度に対応して予め加湿して供給するものである。



【特許請求の範囲】

【請求項1】　固体高分子電解質膜を挟んで両側に、アノード電極とカソード電極とを介装させたセパレータを備えた単位電池を積み重ねて構成した電池スタックをシリーズに接続し、これらシリーズに接続した電池スタックにシリーズに反応ガスを供給してなる燃料電池装置において、前記シリーズに接続した電池スタックの運転温度を前記反応ガスの流れ方向に順次相対的に高温化するとともに、前記反応ガスを最初に流す電池スタックの運転温度に対応して予め加湿して供給することを特徴とする燃料電池装置。

【請求項2】　固体高分子電解質膜を挟んで両側に、アノード電極とカソード電極とを介装させたセパレータを備えた単位電池を積み重ねて構成した電池スタックをシリーズに接続し、これらシリーズに接続した電池スタックにシリーズに反応ガスを供給してなる燃料電池装置において、前記シリーズに接続した電池スタックの運転温度を前記反応ガスの流れ方向に順次相対的に高温化するとともに、前記反応ガスを最初に流す電池スタックの運転温度に対応して予め加湿して供給する一方、前記反応ガスの流れ方向と同一方向に冷却媒体を流す冷却媒体供給手段を備えたことを特徴とする燃料電池装置。

【請求項3】　シリーズに接続した電池スタックを、反応ガスの流れ方向に沿って順次低温運転用、中温運転用、高温運転用の各電池スタックに区画したことを特徴とする請求項1または2に記載の燃料電池装置。

【請求項4】　固体高分子電解質膜を挟んで両側に、アノード電極とカソード電極とを介装させたセパレータを備えた単位電池を積み重ねて構成した電池スタックをシリーズに接続し、これらシリーズに接続した電池スタックにシリーズに反応ガスを供給してなる燃料電池装置において、前記シリーズに接続した電池スタックの運転温度を前記反応ガスの流れ方向に順次相対的に高温化するとともに、前記順次相対的に高温化した少なくとも一つ以上の電池スタックを、さらに前記反応ガスの流れ方向に順次相対的に高温化したサブ電池スタックに区画する一方、前記反応ガスを最初に流すサブ電池スタックの運転温度に対応して予め加湿して供給することを特徴とする燃料電池装置。

【請求項5】　少なくとも一つ以上の電池スタックを区画したサブ電池スタックを、反応ガスの流れ方向に沿って順次低温運転用、中温運転用、高温運転用の各サブ電池スタックに区画したことを特徴とする請求項4に記載の燃料電池装置。

【請求項6】　セパレータに形成する反応ガス供給溝の下流側の開口面積を、前記反応ガス供給溝の上流側の開口面積に較べて相対的に小さく形成したことを特徴とする請求項1、2または4に記載の燃料電池装置。

【請求項7】　固体高分子電解質膜を挟んで両側に、アノード電極とカソード電極とを介装させたセパレータを備えた単位電池を積み重ねて構成した電池スタックをシリーズに接続し、これらシリーズに接続した電池スタックにシリーズに反応ガスを供給してなる燃料電池装置において、前記シリーズに接続した電池スタックの運転温度を前記反応ガスの流れ方向に順次相対的に高温化するとともに、前記反応ガスを最初に流す電池スタックの運転温度に対応して予め加湿して供給する一方、前記順次相対的に高温化した電池スタックに流す前記反応ガスを正方向および逆方向のいずれの方向にも流れる手段を備えたことを特徴とする燃料電池装置。

【請求項8】　固体高分子電解質膜を挟んで両側に、アノード電極とカソード電極とを介装させたセパレータを備えた単位電池を積み重ねて構成した電池スタックをシリーズに接続し、これらシリーズに接続した電池スタックにシリーズに反応ガスを供給してなる燃料電池装置において、前記シリーズに接続した電池スタックの運転温度を前記反応ガスの流れ方向に順次相対的に高温化するとともに、前記順次相対的に高温化した少なくとも一つ以上の電池スタックを、さらに前記反応ガスの流れ方向に順次相対的に高温化したサブ電池スタックに区画し、前記反応ガスを最初に流すサブ電池スタックの運転温度に対応して予め加湿して供給する一方、前記反応ガスの流れ方向と同一方向にシリーズに冷却媒体を流す冷却媒体供給手段を備えたことを特徴とする燃料電池装置。

【請求項9】　固体高分子電解質膜を挟んで両側に、アノード電極とカソード電極とを介装させたセパレータを備えた単位電池を積み重ねて構成した電池スタックをシリーズに接続し、これらシリーズに接続した電池スタックにシリーズに反応ガスを供給してなる燃料電池装置において、前記セパレータに形成する反応ガス供給溝の両側にヘッダを備えたことを特徴とする燃料電池装置。

【請求項10】　ヘッダの底部に、マニホールドを備えたことを特徴とする請求項9に記載の燃料電池装置。

【請求項11】　固体高分子電解質膜を挟んで両側に、アノード電極とカソード電極とを介装させたセパレータを備えた単位電池を積み重ねて構成した電池スタックをシリーズに接続し、これらシリーズに接続した電池スタックにシリーズに反応ガスを供給してなる燃料電池装置において、前記シリーズに接続した電池スタックの運転温度を前記反応ガスの流れ方向に順次相対的に高温化するとともに、前記最初の電池スタックに供給する反応ガスを加湿させる手段と、前記シリーズに接続し、順次相対的に高温化した電池スタックに冷却媒体を循環させる冷却媒体供給装置と、前記シリーズに接続し、順次相対的に高温化した電池スタックに冷却媒体を循環させる冷却媒体供給装置を駆動する制御系とを備えたことを特徴とする燃料電池装置。

【請求項12】　冷却媒体供給装置を、冷却器、タンクおよび循環ポンプを組み合せて構成したことを特徴とする請求項11に記載の燃料電池装置。

【請求項１３】　制御系に、シリーズに接続し、運転温度を反応ガスの流れ方向に順次相対的に高温化した電池スタックの露点温度および湿度のいずれか一方の信号と、前記電気スタックの器内温度信号とに基づいて演算し、前記電池スタックに冷却媒体を供給する冷却媒体供給装置を駆動または停止させる制御演算部を備えたことを特徴とする請求項１１に記載の燃料電池装置。

【請求項１４】　制御系に、シリーズに接続し、運転温度を反応ガスの流れ方向に順次相対的に高温化した電池スタックを構成する単位電池の内部抵抗値の信号と、前記電池スタックの器内温度信号とに基づいて演算し、前記電池スタックに冷却媒体を供給する冷却媒体供給装置を駆動または停止させる制御演算部を備えたことを特徴とする請求項１１に記載の燃料電池装置。

【請求項１５】　制御系に、反応ガスの湿度信号、シリーズに接続し、運転温度を反応ガスの流れ方向に順次相対的に高温化した電池スタックに発生する電流信号および器内温度信号とに基づいて演算し、前記電池スタックに冷却媒体を供給する冷却媒体供給装置を駆動または停止させる制御演算部を備えたことを特徴とする請求項１１に記載の燃料電池装置。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、イオン導電性を備えた固体高分子膜を電解質として用いる燃料電池装置に関する。

【０００２】

【従来の技術】燃料電池装置には、電解質の種類に応じて幾つかの型式のものがある。これらの中でも電解質としてイオン導体性を備えた固体高分子膜を用いた固体高分子電解型燃料電池装置が出力密度が高く、比較的構造をコンパクトにできる等の点で、最近注目されており、その構成として図１０に示すものがある。

【０００３】この固体高分子電解質型燃料電池装置は、その中央に配置する固体高分子電解質膜１を挟んで両側にアノード電極（燃料極）２と、カソード電極（酸化剤極）３とを備えた単位電池（単位セル）４を構成するとともに、各電極２，３に仕切り６ａ，７ａを介して燃料ガス、例えば水素および酸化剤ガス、例えば空気中の酸素のそれぞれを供給する燃料ガス供給溝５ａおよび酸化剤ガス供給溝５ｂを備え、導電性に優れかつ不透過性のセパレータ６，７を設けた構成になっている。

【０００４】アノード電極２は、アノード触媒層２ａとアノード多孔質カーボン平板２ｂとで形成する一方、カソード電極３は、カソード触媒層３ａとカソード多孔質カーボン平板３ｂとで形成される。

【０００５】このような構成を備えた固体高分子電解質型燃料電池装置において、アノード電極２側に燃料ガスが供給され、またカソード電極３側に酸化剤ガスが供給されると、単位電池４は、化学反応し、電流を発生する。すなわち、アノード電極２側に燃料ガスが供給されると、アノード触媒層２ａは、燃料ガスを水素イオンと電子とに分離させ、分離した水素イオンを固体高分子膜１に流すとともに、電子を外部回路（図示せず）に流し、電流を発生させる。

【０００６】また、カソード電極３側に酸化剤ガスが供給されると、カソード触媒層３ａは、酸化剤ガス、特に酸素に上述の固体高分子電解質膜１からの水素イオンおよび外部回路からの電子を反応させ、凝縮水を生成する。その際、アノード電極２側およびカソード電極３側の化学反応式は、それぞれ次式で表わされる。

【０００７】

【化１】

$$\text{アノード電極側} : H_2 \rightarrow 2H^+ + 2e^-$$

$$\text{カソード電極側} : 2H^+ + \frac{1}{2}O_2 + 2e^- \rightarrow H_2O$$

【０００８】なお、カソード電極３側で生成された凝縮水は、未反応ガスとともに単位電池４から器外に放出される。

【０００９】このように、単位電池４は、燃料ガスと酸化剤ガスとを反応させ、起電力を発生させているが、発生する起電力が１Ｖ以下であるため、固体高分子電解質型燃料電池装置では、通常、単位電池４を数十～数百枚にして鉛直方向に積み重ねて電池スタック８を構成している。

【００１０】一方、電解質として適用する固体高分子電解質膜１は、例えばプロトン交換膜に作製するパークルオロロカーボンスルホン酸（商品名：ナフィオン、米国デュポン社製）が用いられている。この固体高分子電解質膜１は、分子中に水素イオンの交換基を持ち、飽和水を保持することによりイオン導電性として良好な機能を持っている。

【００１１】ところで、電池スタック８からより一層高い起電力を発生させるには、固体高分子膜１の開発と相俟って、良好なイオン導電性を確保するために、固体高分子電解質膜１に常に飽和水を保持させておくことが必要とされる。また、カソード電極３側で生成された凝縮水をそのまま放置しておくと、カソード電極３の反応が悪くなるので凝縮水の除去が必要とされる。

【００１２】固体高分子電解質膜１に常に飽和水を保持させるには、運転状態に近い水蒸気を予め反応ガス（燃料ガスおよび酸化剤ガスの両方）に加えて加湿しておけ

ば容易に解決できても、カソード電極３側に生成される凝縮水を除去する手段は、構造が複雑なことも手伝って開発が困難になっており、現在、模索中である。

【００１３】

【発明が解決しようとする課題】最近、カソード電極３側に生成される凝縮水を除去する手段として、反応ガスを供給するセパレータ６，７の燃料ガス供給溝５ａおよび酸化剤ガス供給溝５ｂをサーペンタイン状に形成したり、燃料ガス供給溝５ａおよび酸化剤ガス供給溝５ｂの開口面積を小さくしてガス流速を高め、その速度エネルギーを利用して凝縮水を器外に吹き飛ばす発明が公表されている（アメリカ特許ＵＳＰ－４，９８８，５８３、ＵＳＰ－５，１０８，８４９）。

【００１４】しかし、ガス流速を高めるために、セパレータ６，７の燃料ガス供給溝５ａおよび酸化剤ガス供給溝５ｂの開口面積を小さくすると、各溝５ａ，５ｂの個数がより一層増加し、その作製工数も増加し、電池スタック８を作製するコストがより一層高価になる問題点があった。

【００１５】また、セパレータ６，７の燃料ガス供給溝５ａおよび酸化剤ガス供給溝５ｂの開口面積を小さくした場合、その各溝５ａ，５ｂ内に集められた凝縮水は、器外に吹き飛ばすことができても、カソード触媒層３ａで生成される凝縮水は、カソード多孔質カーボン平板３ｂを介して再びその各溝５ａ，５ｂに押し戻す必要があり、ガス流速を高めただけでは確実に凝縮水を除去できない問題点があった。

【００１６】また、燃料ガス供給溝５ａおよび酸化剤ガス供給溝５ｂに集められた凝縮水を器外に吹き飛ばすには、反応ガスを高圧化する必要があり、反応ガスを高圧化させた分だけエネルギを多く消費し、結果的に熱精算上、プラント熱効率をむしろ低下させる要因になる等の不具合、不都合があった。

【００１７】また、燃料ガス供給溝５ａおよび酸化剤ガス供給溝５ｂをサーペンタイン状に形成すると、反応ガスの圧力損失が増し、結果的により多くの反応ガスを消費させる問題点があった。

【００１８】本発明は、このような問題点に対処してなされたもので、カソード電極側で生成される凝縮水を確実に除去させ、燃料ガスと酸化剤ガスとの反応をより一層促進させて高電池出力化を図った燃料電池装置を提供することを目的とする。

【００１９】

【課題を解決するための手段】本発明に係る燃料電池装置は、上記目的を達成するために、請求項１に記載したように、固体高分子電解質膜を挟んで両側に、アノード電極とカソード電極とを介装させたセパレータを備えた単位電池を積み重ねて構成した電池スタックをシリーズに接続し、これらシリーズに接続した電池スタックにシリーズに反応ガスを供給してなる燃料電池装置において、前記シリーズに接続した電池スタックの運転温度を前記反応ガスの流れ方向に順次相対的に高温化するとともに、前記反応ガスを最初に流す電池スタックの運転温度に対応して予め加湿して供給するものである。

【００２０】また、本発明に係る燃料電池装置は、上記目的を達成するために、請求項２に記載したように、固体高分子電解質膜を挟んで両側に、アノード電極とカソード電極とを介装させたセパレータを備えた単位電池を積み重ねて構成した電池スタックをシリーズに接続し、これらシリーズに接続した電池スタックにシリーズに反応ガスを供給してなる燃料電池装置において、前記シリーズに接続した電池スタックの運転温度を前記反応ガスの流れ方向に順次相対的に高温化するとともに、前記反応ガスを最初に流す電池スタックの運転温度に対応して予め加湿して供給する一方、前記反応ガスの流れ方向と同一方向に冷却媒体を流す冷却媒体供給手段を備えたものである。

【００２１】また、本発明に係る燃料電池装置は、上記目的を達成するために、請求項３に記載したように、シリーズに接続した電池スタックを、反応ガスの流れ方向に沿って順次低温運転用、中温運転用、高温運転用の各電池スタックに区画したものである。

【００２２】また、本発明に係る燃料電池装置は、上記目的を達成するために、請求項４に記載したように、固体高分子電解質膜を挟んで両側に、アノード電極とカソード電極とを介装させたセパレータを備えた単位電池を積み重ねて構成した電池スタックをシリーズに接続し、これらシリーズに接続した電池スタックにシリーズに反応ガスを供給してなる燃料電池装置において、前記シリーズに接続した電池スタックの運転温度を前記反応ガスの流れ方向に順次相対的に高温化するとともに、前記順次相対的に高温化した少なくとも一つ以上の電池スタックを、さらに前記反応ガスの流れ方向に順次相対的に高温化したサブ電池スタックに区画する一方、前記反応ガスを最初に流すサブ電池スタックの運転温度に対応して予め加湿して供給するものである。

【００２３】また、本発明に係る燃料電池装置は、上記目的を達成するために、請求項５に記載したように、少なくとも一つ以上の電池スタックを区画したサブ電池スタックを、反応ガスの流れ方向に沿って順次低温運転用、中温運転用、高温運転用の各サブ電池スタックに区画したものである。

【００２４】また、本発明に係る燃料電池装置は、上記目的を達成するために、請求項６に記載したように、セパレータに形成する反応ガス供給溝の下流側の開口面積を、前記反応ガス供給溝の上流側の開口面積に較べて相対的に小さく形成したものである。

【００２５】また、本発明に係る燃料電池装置は、上記目的を達成するために、請求項７に記載したように、固体高分子電解質膜を挟んで両側に、アノード電極とカソ

ード電極とを介装させたセパレータを備えた単位電池を積み重ねて構成した電池スタックをシリーズに接続し、これらシリーズに接続した電池スタックにシリーズに反応ガスを供給してなる燃料電池装置において、前記シリーズに接続した電池スタックの運転温度を前記反応ガスの流れ方向に順次相対的に高温化するとともに、前記反応ガスを最初に流す電池スタックの運転温度に対応して予め加湿して供給する一方、前記順次相対的に高温化した電池スタックに流す前記反応ガスを正方向および逆方向のいずれの方向にも流れる手段を備えたものである。

【００２６】また、本発明に係る燃料電池装置は、上記目的を達成するために、請求項８に記載したように、固体高分子電解質膜を挟んで両側に、アノード電極とカソード電極とを介装させたセパレータを備えた単位電池を積み重ねて構成した電池スタックをシリーズに接続し、これらシリーズに接続した電池スタックにシリーズに反応ガスを供給してなる燃料電池装置において、前記シリーズに接続した電池スタックの運転温度を前記反応ガスの流れ方向に順次相対的に高温化するとともに、前記順次相対的に高温化した少なくとも一つ以上の電池スタックを、さらに前記反応ガスの流れ方向に順次相対的に高温化したサブ電池スタックに区画し、前記反応ガスを最初に流すサブ電池スタックの運転温度に対応して予め加湿して供給する一方、前記反応ガスの流れ方向と同一方向にシリーズに冷却媒体を流す冷却媒体供給手段を備えたものである。

【００２７】また、本発明に係る燃料電池装置は、上記目的を達成するために、請求項９に記載したように、固体高分子電解質膜を挟んで両側に、アノード電極とカソード電極とを介装させたセパレータを備えた単位電池を積み重ねて構成した電池スタックをシリーズに接続し、これらシリーズに接続した電池スタックにシリーズに反応ガスを供給してなる燃料電池装置において、前記セパレータに形成する反応ガス供給溝の両側にヘッダを備えたものである。

【００２８】また、本発明に係る燃料電池装置は、上記目的を達成するために、請求項１０に記載したように、ヘッダの底部に、マニホールドを備えたものである。

【００２９】また、本発明に係る燃料電池装置は、上記目的を達成するために、請求項１１に記載したように、固体高分子電解質膜を挟んで両側に、アノード電極とカソード電極とを介装させたセパレータを備えた単位電池を積み重ねて構成した電池スタックをシリーズに接続し、これらシリーズに接続した電池スタックにシリーズに反応ガスを供給してなる燃料電池装置において、前記シリーズに接続した電池スタックの運転温度を前記反応ガスの流れ方向に順次相対的に高温化するとともに、前記最初の電池スタックに供給する反応ガスを加湿させる手段と、前記シリーズに接続し、順次相対的に高温化した電池スタックに冷却媒体を循環させる冷却媒体供給装置と、前記シリーズに接続し、順次相対的に高温化した電池スタックに冷却媒体を循環させる冷却媒体供給装置を駆動する制御系とを備えたものである。

【００３０】また、本発明に係る燃料電池装置は、上記目的を達成するために、請求項１２に記載したように、冷却媒体供給装置を、冷却器、タンクおよび循環ポンプを組み合せて構成したものである。

【００３１】また、本発明に係る燃料電池装置は、上記目的を達成するために、請求項１３に記載したように、制御系に、シリーズに接続し、運転温度を反応ガスの流れ方向に順次相対的に高温化した電池スタックの露点温度および湿度のいずれか一方の信号と、前記電気スタックの器内温度信号とに基づいて演算し、前記電池スタックに冷却媒体を供給する冷却媒体供給装置を駆動または停止させる制御演算部を備えたものである。

【００３２】また、本発明に係る燃料電池装置は、上記目的を達成するために、請求項１４に記載したように、制御系に、シリーズに接続し、運転温度を反応ガスの流れ方向に順次相対的に高温化した電池スタックを構成する単位電池の内部抵抗値の信号と、前記電池スタックの器内温度信号とに基づいて演算し、前記電池スタックに冷却媒体を供給する冷却媒体供給装置を駆動または停止させる制御演算部を備えたものである。

【００３３】また、本発明に係る燃料電池装置は、上記目的を達成するために、請求項１５に記載したように、制御系に、反応ガスの湿度信号、シリーズに接続し、運転温度を反応ガスの流れ方向に順次相対的に高温化した電池スタックに発生する電流信号および器内温度信号とに基づいて演算し、前記電池スタックに冷却媒体を供給する冷却媒体供給装置を駆動または停止させる制御演算部を備えたものである。

【００３４】

【発明の実施の形態】以下、本発明に係る燃料電池装置の実施形態を図面および図中に付した符号を用いて説明する。

【００３５】図1は、本発明に係る燃料電池装置の第１実施形態を示す模式図である。

【００３６】本実施形態に係る燃料電池装置は、例えば有効面積を１６９cm² とする平板状の単位電池（単位セル）１０を、鉛直方向に１０枚にして積み重ねて電池スタック１１を構成し、その電池スタック１１を、例えば低温運転用電池スタック１１ａ、中温運転用電池スタック１１ｂ、高温運転用電池スタック１１ｃに区画して電気的に接続するとともに、各低、中、高温運転用電池スタック１１ａ，１１ｂ，１１ｃのうち、低温運転用電池スタック１１ａから高温運転用電池スタック１１ｃに向って燃料ガスおよび酸化剤ガスを連続的に流す構成にしたものである。なお、本実施形態では、低、中、高温運転用電池スタック１１ａ，１１ｂ，１１のそれぞれの運転温度を５０℃，６０℃，６５℃に設定し、低、中、高

温運転用電池スタック１１ａ，１１ｂ，１１ｃに供給される燃料ガスおよび酸化剤ガスに予め水蒸気を加えて加湿し、低、中、高温運転用電池スタック１１ａ，１１ｂ，１１ｃの運転温度に見合うように上述の反応ガスの湿度を高くしてある。

【００３７】また、反応ガス（燃料ガスおよび酸化剤ガスの両方）が低温運転用電池スタック１１ａから順次高温運転用電池スタック１１ｃに向って流れる際、その上流側で反応消費率（利用率）が高く、その下流側で反応消費率が低く、反応ガスのアノード電極側およびカソード電極側に対する拡散割合が低くなるので、本実施形態では、その下流側の燃料ガス供給溝および酸化剤供給溝（ともに図示せず）の開口面積を、上流側のそれに較べて相対的に小さくさせ、反応ガスの流速を高めて反応効率を均一化させる構成になっている。具体的には、燃料ガス供給溝および酸化剤ガス供給溝は、ともにピッチを同一にし、その深さ比を、低、中、高温運転用電池スタック１１ａ，１１ｂ，１１ｃに対し、４：３：１に形成してある。

【００３８】このような構成を備えた本実施形態では、テスト運転の結果、電池出力運転時間が３０００時間で、負荷電流密度が４００ｍＡ／cm² 、燃料ガスの反応消費率（利用率）が８０％、酸化剤ガスの反応消費率（利用率）が５０％になり、従来に較べて向上した。

【００３９】また、本実施形態では、電池スタック１１を、低、中、高温運転用電池スタック１１ａ，１１ｂ，１１ｃに区画したので、従来のように、運転温度を一定とする一つの電池スタックに較べて平均電圧が５％増加し、しかも変動分布の少ない安定した電池出力を発生することが認められた。

【００４０】このように、本実施形態では、電池スタック１１を、低、中、高温運転用電池スタック１１ａ，１１ｂ，１１ｃのそれぞれに区画し、区画した低、中、高温運転用電池スタック１１ａ，１１ｂ，１１ｃを電気的に直列接続させる一方、反応ガスを低温運転用電池スタック１１ａから順次、高温運転用電池スタック１１ｃに向って連続に流す構成にしたので、安定した電池出力を発生させることができ、反応ガスの反応消費率（利用率）をより一層向上させることができる。

【００４１】すなわち、反応ガスを低、中、高温運転用電池スタック１１ａ，１１ｂ，１１ｃに順次、連続に流しているので、例えば低温運転用電池スタック１１ａで反応ガスの未反応部分が比較的多くなっても、隣りの中温運転用または高温運転用電池スタック１１ｂ，１１ｃで反応させ、反応ガスをあますところなく消費させることができる。

【００４２】また、本実施形態では、下流側の燃料ガス供給溝および酸化剤ガス供給溝の開口面積を、上流側のそれに較べて相対的に小さくさせて反応ガスの流速を高めたので、反応効率の均一化を図ることができ、安定した電池出力を発生させることができる。

【００４３】したがって、本実施形態によれば、反応ガスを、低、中、高温運転用電池スタック１１ａ，１１ｂ，１１ｃのそれぞれに過剰に供給しなくとも安定した電池出力を促進することができるので、従来に較べて反応ガスの供給量を少なくさせることができる。

【００４４】また、本実施形態では、低、中、高温運転用電池スタック１１ａ，１１ｂ，１１ｃのそれぞれの運転温度を、反応ガスの流れに沿って順次高くしたので、仮に低温運転用電池スタック１１ａのカーボン電極側での酸化剤ガスの反応の際、生成される凝縮水が多くなっても、運転温度の高い順の中温運転用または高温運転用電池スタック１１ｂ，１１ｃで蒸発させるので、酸化剤ガスの反応を良好に行わせることができる。なお、低、中、高温運転用電池スタック１１ａ，１１ｂ，１１ｃのそれぞれは、別個独立に設置しても良いが、別個独立に設置すると、特定の電池スタックに過電池出力の可能性があるので、電気的に直列接続することが好ましい。

【００４５】図２は、本発明に係る燃料電池装置の第２実施形態を示す模式図である。なお、第１実施形態の構成部分と同一または対応する部分には同一符号を付す。

【００４６】本実施形態に係る燃料電池装置は、第１実施形態と同様に、電池スタック１１を、例えば低、中、高温運転用電池スタック１１ａ，１ｂ，１１ｃに区画し、低、中、高温運転用電池スタック１１ａ，１１ｂ，１１ｃを電気的に直列接続させるとともに、低、中、高温運転用電池スタック１１ａ，１１ｂ，１１ｃに連続して冷却媒体、例えば冷却水を供給する冷却媒体供給手段１２、例えば冷却水配管を設けたものである。なお、低温運転用電池スタック１１ａの運転温度は、冷却媒体供給手段１２から供給される冷却媒体の温度により決定される。また、高温運転用電池スタック１１ｃの運転温度は、高温運転用電池スタック１１ｃから排出される冷却媒体の温度を計測し、冷却媒体量を調整することにより決定される。さらに、中温運転用電池スタック１１ｂの運転温度は、低温運転用電池スタック１１ａの運転温度と、高温運転用電池スタック１１ｃの運転温度との平均温度を採用する。

【００４７】このように、本実施形態では、低、中、高温運転用電池スタック１１ａ，１１ｂ，１１ｃに冷却媒体を連続して供給する冷却媒体供給手段１２を設け、低、中、高温運転用電池スタック１１ａ，１１ｂ，１１ｃのより一層の温度傾斜化を図ったので、仮に低温運転用電池スタック１１ａのカソード電極側で酸化剤ガスを反応させる際、生成される凝縮水が多くなっても隣りの中温運転用または高温運転用電池スタック１１ｂ，１１ｃで蒸発の促進を確実に行わせることができ、酸化剤ガスのより一層の反応を高めて安定した電池出力を発生させることができる。

【００４８】図３は、本発明に係る燃料電池装置の第３

実施形態を示す模式図である。なお、第１実施形態の構成部分と同一または対応する部分には同一符号を付す。

【００４９】本実施形態に係る燃料電池装置は、第１実施形態で示した低、中、高温運転用電池スタック１１ａ，１１ｂ，１１ｃのうち、低温運転用電池スタック１１ａを、さらに低、中、高温運転用サブ電池スタック$11a_1$，$11a_2$，$11a_3$のそれぞれに区画するとともに、低、中、高温運転用サブ電池スタック$11a_1$，$11a_2$，$11a_3$を反応ガス（燃料ガスおよび酸化剤ガスの両方）の流れの方向と同一方向に直列接続させたものである。なお、中、高温運転用電池スタック１１ｂ，１１ｃも、上述と同様に、低温運転用サブ電池スタック$11b_1$，$11c_1$、中温運転用サブ電池スタック$11b_2$，$11c_2$、高温運転用サブ電池スタック$11b_3$，$11c_3$に区画される。

【００５０】一般に、電池スタック１１は、単独電池１０を例に採ると、その入口側の方がその出口側に較べて反応ガスの反応消費率（利用率）が低いのに対し、電池出力密度が高くなる傾向にある。

【００５１】本実施形態では、このような点に着目したもので、低、中、高温運転用電池スタック１１ａ，１１ｂ，１１ｃ毎に、低、中、高温運転用サブ電池スタック$11a_1$，$11b_1$，$11c_1$，$11a_2$，$11b_2$，$11c_2$，…に細かく区画したものである。

【００５２】また、本実施形態では、低、中、高温運転用電池スタック１１ａ，１１ｂ，１１ｃ毎に区画した低、中、高温運転用サブ電池スタック$11a_1$，$11b_1$，$11c_1$，$11a_2$，$11b_2$，$11c_2$，…に反応ガス（燃料ガスおよび酸化剤ガスの両方）を供給する燃料ガス供給溝および酸化剤ガス供給溝（ともに図示せず）の開口面積を、上流側に較べて下流側を相対的に小さくさせ、反応ガスの流体を高めて反応効率を均一化させる構成になっている。具体的には、第１実施形態と同様に、ともにピッチを同一にし、その深さ比を、低、中、高温運転用サブ電池スタック$11a_1$，$11b_1$，$11c_1$，$11a_2$，$11b_2$，$11c_2$，…に対し、４：３：１に形成してある。

【００５３】このように、本実施形態では、低、中、高温運転用電池スタック１１ａ，１１ｂ，１１ｃ毎に、低、中、高温運転用サブ電池スタック$11a_1$，$11b_1$，$11c_1$，$11a_2$，$11b_2$，$11c_2$，…と細かく区画したので、低、中、高温運転用電池スタック１１ａ，１１ｂ，１１ｃからのむらのない安定した電池出力を発生させることができる。

【００５４】また、本実施形態では、低、中、高温運転用電池スタック１１ａ，１１ｂ，１１ｃ毎に、低、中、高温運転用サブ電池スタック$11a_1$，$11b_1$，$11c_1$，$11a_2$，$11b_2$，$11c_2$，…と細かく区画したので、酸化剤ガスの反応の際、生成される凝縮水をより一層蒸発させることができ、酸化剤ガスの反応を良好に促進させることができる。

【００５５】また、本実施形態では、下流側の燃料ガス供給溝および酸化剤ガス供給溝の開口面積を、上流側のそれに較べて相対的に小さくさせて反応ガスの流速を高めたので、反応高率のより一層の均一化を図ることができ、安定した電池出力を発生させることができる。

【００５６】図4は、本発明に係る燃料電池装置の第４実施形態を示す模式図である。なお、第１実施形態の構成部分と同一部分または対応する部分には同一符号を付す。

【００５７】本実施形態に係る燃料電池装置は、第１実施形態と同様に、電池スタック１１を、例えば低、中、高温運転用電池スタック１１ａ，１１ｂ，１１ｃに区画するとともに、低温運転用電池スタック１１ａから順次、中、高温運転用電池スタック１１ｂ，１１ｃに供給していた反応ガスを、予め定められた運転時間経過後、逆方向に供給する構成にしたものである。具体的には、配管に設置したバルブ（図示せず）を切り替え、反応ガスを図示の流れ方向と逆方向に流すことにより行われる。なお、反応ガスを、予め定められた運転時間経過後、逆方向に流す運転方法は、図３で示した第３実施形態にも適用される。

【００５８】このように、本実施形態では、反応ガスを、予め定められた運転時間経過後、逆方向に流す構成にしたので、低、中、高温運転用電池スタック１１ａ，１１ｂ，１１ｃの電池特性の低下を低く抑えることができ、安定した電池出力の発生を長く維持させることができる。

【００５９】図5は、本発明に係る燃料電池装置の第５実施形態を示す模式図である。なお、第１実施形態、第２実施形態および第３実施形態の構成部分と同一または対応する部分には同一符号を付す。

【００６０】本実施形態に係る燃料電池装置は、第１実施形態に、第２実施形態および第３実施形態を組み合せたもので、低、中、高温運転用電池スタック１１ａ，１１ｂ，１１ｃ毎に低、中、高温運転用サブ電池スタック$11a_1$，$11b_1$，$11c_1$，$11a_2$，$11b_2$，$11c_2$，…を区画するとともに、反応ガスの流れ方向と同一方向に冷却媒体を流す冷却供給手段１２を設けたものである。

【００６１】このように、本実施形態では、低、中、高温運転用サブ電池スタック$11a_1$，$11b_1$，$11c_1$，$11a_2$，$11b_2$，$11c_2$，…の反応ガスの流れ方向と同一方向に冷却媒体を連続して供給する冷却媒体供給手段１２を設け、低、中、高温運転用サブ電池スタック$11a_1$，$11b_1$，$11c_1$，$11a_2$，$11b_2$，$11c_2$，…のより一層の温度傾斜化を図ったので、各サブ電池スタック$11a_1$，$11b_1$，$11c_1$，$11a_2$，$11b_2$，$11c_2$，…のカーボン電極側で生成される凝縮水の蒸発をより一層促進させるこ

とができ、安定した電池出力を発生させることができる。

【００６２】図6は、本発明に係る燃料電池装置に適用するセパレータの実施形態を示す概略図である。

【００６３】本実施形態に係るセパレータ１３は、反応ガスを供給する反応ガス供給溝１４を、鉛直方向に沿って複数個形成するとともに、反応ガス供給溝１４の両端に、入口マニホールド１５ａを備えた入口ヘッド１５と、出口マニホールド１６ａを備えた出口ヘッダ１６とを設けたものである。

【００６４】このように、本実施形態では、セパレータ１３の反応ガス供給溝１４の両端に、入口ヘッダ１５と出口ヘッダ１６とを設け、より多くの反応ガスを供給するので、従来に較べてより一層高い電池出力を発生させることができる。

【００６５】また、本実施形態では、反応ガス供給溝１４の両端に、入口ヘッダ１５と出口ヘッダ１６とを備えたので、反応ガスから生成される凝縮水をより多く処理することができ、従来のように反応ガス供給溝１４の構造、形状を複雑化させることもなく、その作製工数時間を少なくさせてコスト低減に寄与することができる。なお、本実施形態は、入口ヘッダ１５と出口ヘッダ１６との底部側に入口、出口のマニホールド１５ａ，１６ａを備えているので、反応ガスの給排出口の切替を自由に行うことができる。

【００６６】図7は、本発明に係る燃料電池装置に適用する電池スタックの運転温度を制御する実施形態を示す概略制御系統図である。なお、第１実施形態の構成部分と同一部分には同一符号を付す。

【００６７】本実施形態に係る電池スタック１１は、例えば有効面積を１６９cm² とする平板状の単位電池（単位セル）１０を、鉛直方向に３０枚にして積み重ねた構成になっている。

【００６８】この電池スタック１１は、その入口側に燃料ガスおよび酸化剤ガスを加湿させる加湿器１７ａ，１７ｂと、その出口側に酸化剤ガスの湿度を測定する露点計１８を備えている。なお、露点計１８は湿度計で良い。

【００６９】また、電池スタック１１は、その器内の運転温度を調整するために、冷却媒体、例えば冷却水を供給する冷却器１９、タンク２０、循環ポンプ２１を組み合せた冷却媒体供給装置２２と、冷却器１９および循環ポンプ２１に制御信号を与える制御演算部２３とを備えた構成になっている。

【００７０】このような構成を備えた電池スタック１１において、今、器内の運転温度を、例えば８０℃に設定したとき、器内の運転温度が８０℃よりも下廻り、露点計１８で測定した温度が例えば７８℃以下になった場合、制御演算部２３は、器内運転温度と露点計１８の測定温度に基づいて演算し、その演算信号を冷却器１９および循環ポンプ２１に与えて冷却器１９および循環ポンプ２１を駆動させるようになっている。また、器内の運転運転温度よりも高くなったとき、制御演算部２３は、その演算信号を冷却器１９および循環ポンプ２１に与えて冷却器１９および循環ポンプ２１の駆動を停止させるようになっている。

【００７１】このように、本実施形態では、電池スタック１１に、冷却媒体供給装置２２と制御演算部２３とを設け、器内設定運転温度に対し、下廻ったとき、器内で生成される凝縮水を促進させ、逆に器内設定運転温度に対し、上廻ったとき、器内で生成される凝縮水の蒸発を促進させたので、電池スタック１１から発生する電池出力を従来に較べてより一層高めることができる。ちなみに、実験によれば、電圧低下速度は、従来の運転温度一定に較べて１／３以下に低くすることができた。

【００７２】図8は、本発明に係る燃料電池装置に適用する電池スタックの運転温度を制御する、図７に示した実施形態の第１変形例を示す制御系統図である。

【００７３】本実施例では、図７で示した実施形態の構成と同一にするとともに、電池スタック１１に、単位電池１０の内部抵抗を測定する抵抗測定装置２４を付設し、抵抗測定装置２４からの抵抗信号と器内温度信号とに基づいて制御演算部２３で演算させ、冷却媒体供給装置２２を駆動させたものである。

【００７４】抵抗測定装置２４は、器内の運転温度を、例えば８０℃に設定したとき、単位電池１０の内部抵抗値が例えば９０Ωcm² 以上になると、冷却媒体供給装置２２を駆動させて電池スタック１１の運転温度を低下させ、逆に９０Ωcm² 以下になると、冷却媒体供給装置２２の駆動を停止させ、電池スタック１１の運転温度を高める構成になっている。

【００７５】したがって、本実施例によれば、器内に生成される凝縮水の多少量に応じて電池スタック１１の運転温度を制御できるので、電池スタック１１から発生する電池出力を従来に比べてより一層高めることができる。

【００７６】なお、本実施例では、電池スタック１１に抵抗測定装置２４を付設したが、図9に示すように、電池スタック１１に負荷電流計２５を付設し、負荷電流計２５からの電流信号、加湿器１７ａ，１７ｂからの信号および温度計２６からの器内温度信号に基づいて制御演算部２３で演算させ、冷却媒体供給装置２２を駆動させても良い。

【００７７】

【発明の効果】以上の説明のとおり、本発明に係る燃料電池装置は、電池スタックをシリーズに接続し、シリーズに接続した電池スタックの運転温度を反応ガスの流れ方向に順次相対的に高温化するとともに、反応ガスを最初に流す電池スタックの運転温度に対応して予め加湿するので、反応ガスの反応消費率を高めて、安定した電池

出力を発生させることができる。

【0078】また、本発明に係る燃料電池装置は、電池スタックをシリーズに接続し、シリーズに接続した電池スタックの運転温度を反応ガスの流れ方向に順次相対的に高温化するとともに、反応ガスを最初に流す電池スタックの運転温度に対応して予め加湿させる一方、反応ガスの流れ方向と同一方向に冷却媒体を流す冷却媒体供給手段を備え、各電池スタックの温度傾斜化を図ったので、酸化剤ガスの反応の際、生成される凝縮水の蒸発を促進させて安定した電池出力を発生させることができる。

【0079】また、本発明に係る燃料電池装置は、電池スタックをシリーズに接続し、シリーズに接続した電池スタックの運転温度を反応ガスの流れ方向に順次相対的に高温化するとともに、順次相対的に高温化した少なくとも一つ以上の電池スタックを、さらに反応ガスの流れ方向に順次相対的に高温化したサブ電池スタックに区画する一方、反応ガスを最初に流すサブ電池スタックの運転温度に対応して予め加湿するので、反応ガスの反応消費率をより一層高めて、安定した電池出力を発生させることができる。

【0080】また、本発明に係る燃料電池装置は、電池スタックをシリーズに接続し、シリーズに接続した電池スタックの運転温度を反応ガスの流れ方向に順次相対的に高温化するとともに、高温化した電池スタックに流す反応ガスを正逆のいずれの方向にも流すことのできる構成にしたので、安定した電池出力の発生を長く維持させることができる。

【0081】また、本発明に係る燃料電池装置は、セパレートの反応ガス供給溝の両端にヘッダを設けてより多く反応ガスを供給できる構成にしたので、簡素化させた構造の下、より一層高い電池出力を発生させることができる。

【0082】また、本発明に係る燃料電池装置は、電池スタックの運転温度を調整する冷却媒体供給装置と、冷却媒体供給装置を制御する制御系を設けたので、電池スタックに生成される凝縮水を運転状態に対応させた好ましい水量に調整することができる。

【図面の簡単な説明】

【図1】本発明に係る燃料電池装置の第1実施形態を示す構成図。

【図2】本発明に係る燃料電池装置の第2実施形態を示す模式図。

【図3】本発明に係る燃料電池装置の第3実施形態を示す模式図。

【図4】本発明に係る燃料電池装置の第4実施形態を示す模式図。

【図5】本発明に係る燃料電池装置の第5実施形態を示す模式図。

【図6】本発明に係る燃料電池装置に適用するセパレータの実施形態を示す概略図。

【図7】本発明に係る燃料電池装置に適用する電池スタックの運転温度を制御する実施形態を示す概略制御系統図。

【図8】本発明に係る燃料電池装置に適用する電池スタックの運転温度を制御する実施形態における第1変形例を示す概略制御系統図。

【図9】本発明に係る燃料電池装置に適用する電池スタックの運転温度を制御する実施形態における第2変形例を示す概略制御系統図。

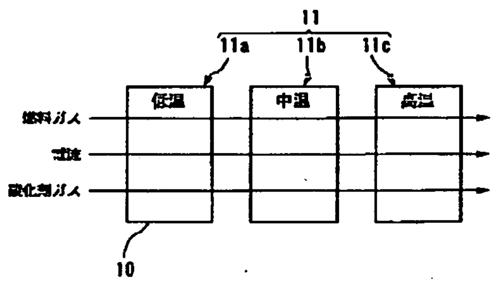
【図10】従来の燃料電池装置における単位電池を示す模式図。

【符号の説明】

1　固体高分子電解質膜
2　アノード電極
2a　アノード触媒層
2b　アノード多孔質カーボン平板
3　カソード電極
3a　カソード触媒層
3b　カソード多孔質カーボン平板
4，10　単位電池
5a　燃料ガス供給溝
5b　酸化剤ガス供給溝
6，7　セパレータ
6a，7a　仕切り
8　電池スタック
10　単位電池
11　電池スタック
11a　低温運転用電池スタック
$11a_1$，$11b_1$，$11c_1$　低温運転用サブ電池スタック
11b　中温運転用電池スタック
$11a_2$，$11b_2$，$11c_2$　中温運転用サブ電池スタック
11c　高温運転用電池スタック
$11a_3$，$11b_3$，$11c_3$　高温運転用サブ電池スタック
12　冷却水供給手段
13　セパレータ
14　反応ガス供給溝
15　入口ヘッダ
15a　入口マニホールド
16　出口ヘッダ
16a　出口マニホールド
17a，17b　加湿器
18　露点計
19　冷却器
20　タンク
21　循環ポンプ
22　冷却媒体供給装置

２３　制御演算部
２４　抵抗測定装置
２５　負荷電流計
２６　温度計

【図１】



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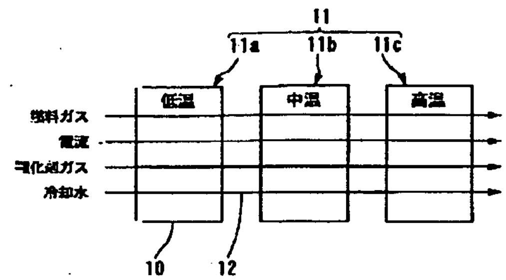

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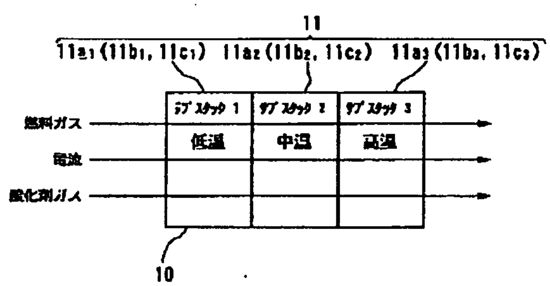
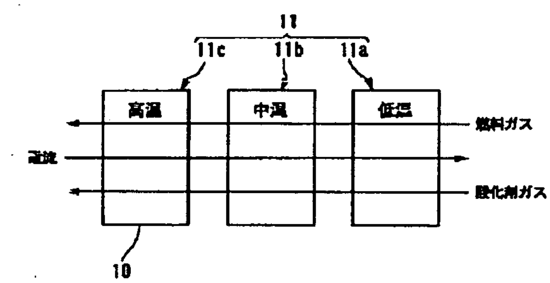


【図４】



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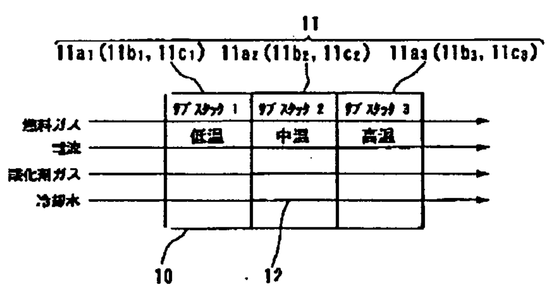

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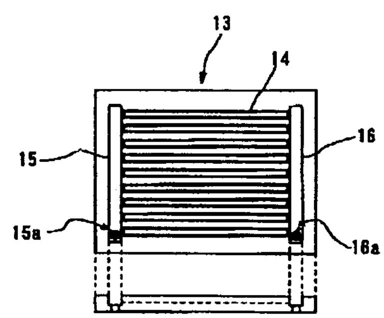

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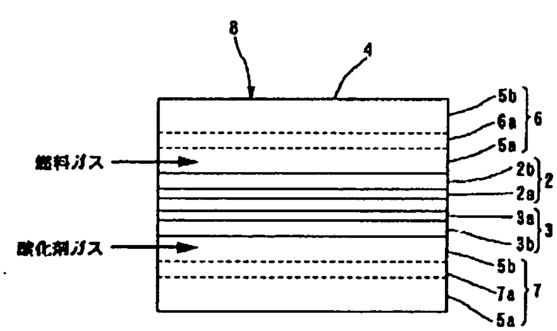
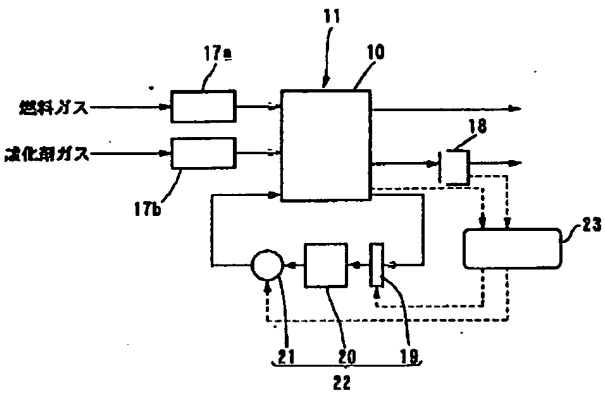
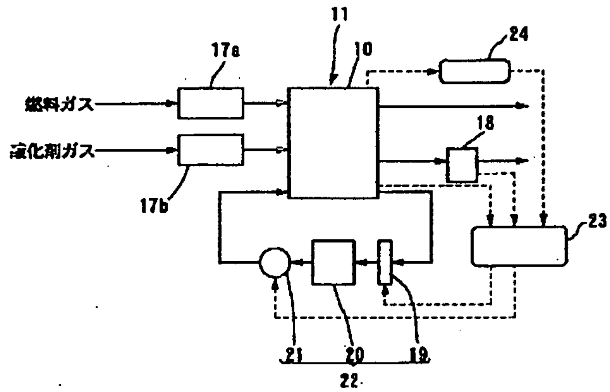


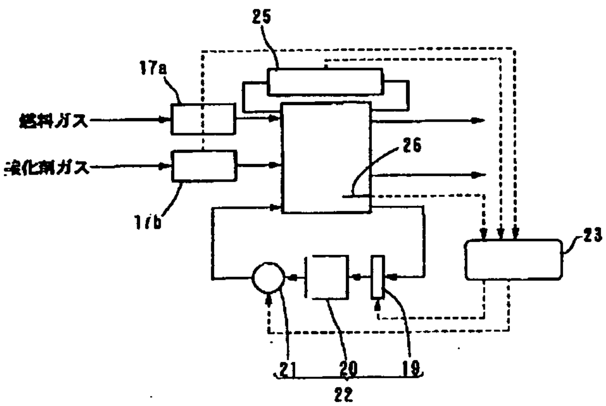
【図7】



【図8】



【図9】



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(72)発明者　上野　三司
神奈川県川崎市川崎区浮島町2番1号　株式会社東芝浜川崎工場内

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CLAIMS

[Claim(s)]
[Claim 1]A cell stack which accumulated and constituted a unit cell provided with a separator which made an anode electrode and a cathode terminal infix in both sides on both sides of solid polyelectrolyte membrane is connected to series, While carrying out the temperature rise of the operating temperature of a cell stack linked to said series relatively [one by one] to a flow direction of said reactant gas in a fuel cell device which supplies reactant gas to series at a cell stack linked to these series, A fuel cell device humidifying said reactant gas beforehand and supplying it corresponding to an operating temperature of a cell stack passed first.
[Claim 2]A cell stack which accumulated and constituted a unit cell provided with a separator which made an anode electrode and a cathode terminal infix in both sides on both sides of solid polyelectrolyte membrane is connected to series, While carrying out the temperature rise of the operating temperature of a cell stack linked to said series relatively [one by one] to a flow direction of said reactant gas in a fuel cell device which supplies reactant gas to series at a cell stack linked to these series, A fuel cell device equipping a flow direction and a uniform direction of said reactant gas with a cooling-medium feeding means which pours a cooling medium while humidifying said reactant gas beforehand and supplying it corresponding to an operating temperature of a cell stack passed first.
[Claim 3]The fuel cell device according to claim 1 or 2 dividing a cell stack linked to series one by one along a flow direction of reactant gas to each cell stack an object for low-temperature operation, for moderate temperature operation, and for high temperature operations.
[Claim 4]A cell stack which accumulated and constituted a unit cell provided with a separator which made an anode electrode and a cathode terminal infix in both sides on both sides of solid polyelectrolyte membrane is connected to series, While carrying out the temperature rise of the operating temperature of a cell stack linked to said series relatively [one by one] to a flow direction of said reactant gas in a fuel cell device which supplies reactant gas to series at a cell stack linked to these series, Said at least one or more cell stacks which carried out the temperature rise relatively one by one, A fuel cell device humidifying said reactant gas beforehand and supplying it corresponding to an operating temperature of a sub cell stack passed first while dividing to a sub cell stack which carried out the temperature rise still more relatively [one by one] to a flow direction of said reactant gas.
[Claim 5]The fuel cell device according to claim 4 dividing a sub cell stack which divided at least one or more cell stacks one by one along a flow direction of reactant gas to an object for low-temperature operation, an object for moderate temperature operation, and each sub cell stack for high temperature operations.
[Claim 6]The fuel cell device according to claim 1, 2, or 4 forming relatively small an effective area product of the downstream of a reactant gas supply groove formed in a separator compared with an effective area product of the upstream of said reactant gas supply groove.
[Claim 7]A cell stack which accumulated and constituted a unit cell provided with a separator which made an anode electrode and a cathode terminal infix in both sides on both sides of solid polyelectrolyte membrane is connected to series, While carrying out the temperature rise of the operating temperature of

a cell stack linked to said series relatively [one by one] to a flow direction of said reactant gas in a fuel cell device which supplies reactant gas to series at a cell stack linked to these series, A fuel cell device having a means which flows through said reactant gas passed to said cell stack which carried out the temperature rise relatively one by one in any direction for Masakata and of an opposite direction while humidifying said reactant gas beforehand and supplying it corresponding to an operating temperature of a cell stack passed first.
[Claim 8]A cell stack which accumulated and constituted a unit cell provided with a separator which made an anode electrode and a cathode terminal infix in both sides on both sides of solid polyelectrolyte membrane is connected to series, While carrying out the temperature rise of the operating temperature of a cell stack linked to said series relatively [one by one] to a flow direction of said reactant gas in a fuel cell device which supplies reactant gas to series at a cell stack linked to these series, Said at least one or more cell stacks which carried out the temperature rise relatively one by one, It divides to a sub cell stack which carried out the temperature rise still more relatively [one by one] to a flow direction of said reactant gas, A fuel cell device equipping a flow direction and a uniform direction of said reactant gas with a cooling-medium feeding means which pours a cooling medium in series while humidifying said reactant gas beforehand and supplying it corresponding to an operating temperature of a sub cell stack passed first.
[Claim 9]A cell stack which accumulated and constituted a unit cell provided with a separator which made an anode electrode and a cathode terminal infix in both sides on both sides of solid polyelectrolyte membrane is connected to series, A fuel cell device equipping with a header both sides of a reactant gas supply groove formed in said separator in a fuel cell device which supplies reactant gas to series at a cell stack linked to these series.
[Claim 10]The fuel cell device according to claim 9 equipping a pars basilaris ossis occipitalis of a header with a manifold.
[Claim 11]On both sides of solid polyelectrolyte membrane characterized by comprising the following, on both sides. A fuel cell device which supplies reactant gas to a cell stack which connected to series a cell stack which accumulated and constituted a unit cell provided with a separator in which an anode electrode and a cathode terminal were made to infix, and was connected to these series at series.
A means to make reactant gas supplied to said first cell stack humidify while carrying out the temperature rise of the operating temperature of a cell stack linked to said series relatively [, one by one] to a flow direction of said reactant gas.
A cooling-medium feed unit which makes a cell stack which was connected to said series and carried out the temperature rise relatively one by one circulate through a cooling medium.
A control system which drives a cooling-medium feed unit which makes a cell stack which was connected to said series and carried out the temperature rise relatively one by one circulate through a cooling medium.

[Claim 12]The fuel cell device according to claim 11 constituting a cooling-medium feed unit combining a condensator, a tank, and a circulating pump.
[Claim 13]The fuel cell device comprising according to claim 11:
A signal of either one of the dew-point temperature of a cell stack, and humidity which connected with series and carried out the temperature rise of the operating temperature to a control system relatively one by one in a flow direction of reactant gas.
A control calculation part which drives or stops a cooling-medium feed unit which calculates based on a vessel internal temperature degree signal of said electric stack, and supplies a cooling medium to said cell stack.

[Claim 14]The fuel cell device comprising according to claim 11:
A signal of an internal resistance value of a unit cell which constitutes a cell stack which connected with series and carried out the temperature rise of the operating temperature to a control system relatively [one by one] to a flow direction of reactant gas.

A control calculation part which drives or stops a cooling-medium feed unit which calculates based on a vessel internal temperature degree signal of said cell stack, and supplies a cooling medium to said cell stack.

[Claim 15]It calculates based on a current signal and a vessel internal temperature degree signal which are generated in a cell stack which connected with a humidity signal of reactant gas, and series, and carried out the temperature rise of the operating temperature to a control system relatively [one by one] to a flow direction of reactant gas, The fuel cell device according to claim 11 provided with a control calculation part which drives or stops a cooling-medium feed unit which supplies a cooling medium to said cell stack.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention]This invention relates to the fuel cell device using the solid polymer membrane provided with ion conductivity as an electrolyte.
[0002]
[Description of the Prior Art]There is a thing of some form in a fuel cell device according to an electrolytic kind. In respect of the solid polymer electrolytic type fuel cell device using the solid polymer membrane provided with ion conductor nature as an electrolyte having high power density, and being able to make structure compact comparatively also in these, etc., it is observed these days and there are some which are shown in drawing 10 as the composition.
[0003]While this solid polyelectrolyte type fuel cell device constitutes the unit cell (unit cell) 4 which equipped both sides with the anode electrode (fuel electrode) 2 and the cathode terminal (oxidizing agent pole) 3 on both sides of the solid polyelectrolyte membrane 1 arranged in that center, It has the fuel gas supply groove 5a and the oxidant gas supply groove 5b which divide into each electrodes 2 and 3 and supply each of oxygen in fuel gas, for example, hydrogen, and oxidant gas, for example, air, via 6a and 7a, and has the composition of having excelled in conductivity and having formed the impermeable separators 6 and 7.
[0004]The anode electrode 2 is formed with the anode catalyst layer 2a and anode porous carbon monotonous 2b.
On the other hand, the cathode terminal 3 is formed with the cathode catalyst bed 3a and the cathode porous carbon plate 3b.

[0005]In the solid polyelectrolyte type fuel cell device provided with such composition, if fuel gas is supplied to the anode electrode 2 side and oxidant gas is supplied to the cathode terminal 3 side, the chemical reaction of the unit cell 4 will be carried out, and it will generate current. That is, if fuel gas is supplied to the anode electrode 2 side, while passing the hydrogen ion which was made to divide fuel gas into a hydrogen ion and an electron, and was separated to the solid polymer membrane 1, the anode catalyst layer 2a will pour an electron to an external circuit (not shown), and will generate current.
[0006]If oxidant gas is supplied to the cathode terminal 3 side, the cathode catalyst bed 3a will make the electron from the above-mentioned hydrogen ion and external circuit from the solid polyelectrolyte membrane 1 react to oxidant gas, especially oxygen, and will generate the water of condensation. In that case, the chemical equation by the side of the anode electrode 2 and the cathode terminal 3 is expressed with a following formula, respectively.
[0007]
[Formula 1]

アノード電極側 : $H_2 \rightarrow 2H^+ + 2e^-$

カソード電極側 : $2H^+ + \frac{1}{2}O_2 + 2e^- \rightarrow H_2O$

[0008]The water of condensation generated by the cathode terminal 3 side is emitted out of a vessel from the unit cell 4 with a unconverted gas.
[0009]Thus, although the unit cell 4 makes fuel gas and oxidant gas react and is generating electromotive force, since the electromotive force to generate is less than 1V, usually it makes the unit cell 4 tens - 100 numbers, accumulates it in the perpendicular direction, and constitutes the cell stack 8 from a solid polyelectrolyte type fuel cell device.
[0010]The park RUORORO carbon sulfonic acid (trade name: Nafion, the U.S. Du Pont make) which, on the other hand, produces the solid polyelectrolyte membrane 1 applied as an electrolyte, for example to proton exchange membrane is used. This solid polyelectrolyte membrane 1 has an exchange group of a hydrogen ion in a molecule, and has a function good as ion conductivity by holding saturated water.
[0011]By the way, in order to generate the still higher electromotive force from the cell stack 8 and to secure good ion conductivity conjointly with development of the solid polymer membrane 1, making saturated water always hold is needed for the solid polyelectrolyte membrane 1. If the water of condensation generated by the cathode terminal 3 side is neglected as it is, since the reaction of the cathode terminal 3 will worsen, removal of the water of condensation is needed.
[0012]In order to make saturated water always hold to the solid polyelectrolyte membrane 1, If the steam near operational status is beforehand added to reactant gas (both fuel gas and oxidant gas) and is humidified, even if easily solvable, that structure is also complicated helps a means to remove the water of condensation generated at the cathode terminal 3 side, and development is difficult and is groping for it now.
[0013]
[Problem(s) to be Solved by the Invention]These days as a means to remove the water of condensation generated at the cathode terminal 3 side, Form the fuel gas supply groove 5a and the oxidant gas supply groove 5b of the separators 6 and 7 which supply reactant gas in the shape of Serpentine, or, The effective area product of the fuel gas supply groove 5a and the oxidant gas supply groove 5b is made small, a gas flow rate is raised, and the invention which blows away the water of condensation besides a vessel using the velocity energy is released (U.S. patent USP-4,988,583, USP-5,108,849).
[0014]However, in order to raise a gas flow rate, when the effective area product of the fuel gas supply groove 5a of the separators 6 and 7 and the oxidant gas supply groove 5b was made small, the number of each slots 5a and 5b increased further, the production man day also increased, and there was a problem that the cost which produces the cell stack 8 became much more expensive.
[0015]The water of condensation collected in each of that slot 5a and 5b when the effective area product of the fuel gas supply groove 5a of the separators 6 and 7 and the oxidant gas supply groove 5b was made small, Even if it could blow away besides the vessel, the water of condensation generated by the cathode catalyst bed 3a needed to be again put back to each of those slots 5a and 5b via the cathode porous carbon plate 3b, and there was a problem that the water of condensation was certainly unremovable only by raising a gas flow rate.
[0016]In order to blow away besides a vessel the water of condensation brought together in the fuel gas supply groove 5a and the oxidant gas supply groove 5b, Reactant gas needed to be high-voltage-ized, only the part which made reactant gas high-voltage-ize consumed many energies, and there were fault, such as becoming a factor which reduces plant thermal efficiency rather, and inconvenience on a sankey diagram as a result.
[0017]When the fuel gas supply groove 5a and the oxidant gas supply groove 5b were formed in the shape of Serpentine, there was a problem that the pressure loss of reactant gas made increase and consequential more much reactant gas consume.

[0018]An object of this invention is to provide the fuel cell device which coped with such a problem, was made, made the water of condensation generated by the cathode terminal side remove certainly, promoted the reaction of fuel gas and oxidant gas further, and attained high cell output-ization.
[0019]
[Means for Solving the Problem]To achieve the above objects, as indicated to claim 1, a fuel cell device concerning this invention, A cell stack which accumulated and constituted a unit cell provided with a separator which made an anode electrode and a cathode terminal infix in both sides on both sides of solid polyelectrolyte membrane is connected to series, While carrying out the temperature rise of the operating temperature of a cell stack linked to said series relatively [one by one] to a flow direction of said reactant gas in a fuel cell device which supplies reactant gas to series at a cell stack linked to these series, Corresponding to an operating temperature of a cell stack passed first, said reactant gas is humidified beforehand and supplied.
[0020]To achieve the above objects, as indicated to claim 2, a fuel cell device concerning this invention, A cell stack which accumulated and constituted a unit cell provided with a separator which made an anode electrode and a cathode terminal infix in both sides on both sides of solid polyelectrolyte membrane is connected to series, While carrying out the temperature rise of the operating temperature of a cell stack linked to said series relatively [one by one] to a flow direction of said reactant gas in a fuel cell device which supplies reactant gas to series at a cell stack linked to these series, While humidifying said reactant gas beforehand and supplying it corresponding to an operating temperature of a cell stack passed first, a flow direction and a uniform direction of said reactant gas are equipped with a cooling-medium feeding means which pours a cooling medium.
[0021]To achieve the above objects, a fuel cell device concerning this invention divides a cell stack linked to series one by one along a flow direction of reactant gas to each cell stack an object for low-temperature operation, for moderate temperature operation, and for high temperature operations, as indicated to claim 3.
[0022]To achieve the above objects, as indicated to claim 4, a fuel cell device concerning this invention, A cell stack which accumulated and constituted a unit cell provided with a separator which made an anode electrode and a cathode terminal infix in both sides on both sides of solid polyelectrolyte membrane is connected to series, While carrying out the temperature rise of the operating temperature of a cell stack linked to said series relatively [one by one] to a flow direction of said reactant gas in a fuel cell device which supplies reactant gas to series at a cell stack linked to these series, While dividing said at least one or more cell stacks which carried out the temperature rise relatively one by one to a sub cell stack which carried out the temperature rise still more relatively [one by one] to a flow direction of said reactant gas, corresponding to an operating temperature of a sub cell stack passed first, said reactant gas is humidified beforehand and supplied.
[0023]To achieve the above objects, as indicated to claim 5, a fuel cell device concerning this invention, A sub cell stack which divided at least one or more cell stacks is divided one by one along a flow direction of reactant gas to an object for low-temperature operation, an object for moderate temperature operation, and each sub cell stack for high temperature operations.
[0024]To achieve the above objects, a fuel cell device concerning this invention forms relatively small an effective area product of the downstream of a reactant gas supply groove formed in a separator compared with an effective area product of the upstream of said reactant gas supply groove, as indicated to claim 6.
[0025]To achieve the above objects, as indicated to claim 7, a fuel cell device concerning this invention, A cell stack which accumulated and constituted a unit cell provided with a separator which made an anode electrode and a cathode terminal infix in both sides on both sides of solid polyelectrolyte membrane is connected to series, While carrying out the temperature rise of the operating temperature of a cell stack linked to said series relatively [one by one] to a flow direction of said reactant gas in a fuel cell device which supplies reactant gas to series at a cell stack linked to these series, While humidifying said reactant gas beforehand and supplying it corresponding to an operating temperature of a cell stack passed first, it has a means which flows through said reactant gas passed to said cell stack which carried

out the temperature rise relatively one by one in any direction for Masakata and of an opposite direction.

[0026]To achieve the above objects, as indicated to claim 8, a fuel cell device concerning this invention, A cell stack which accumulated and constituted a unit cell provided with a separator which made an anode electrode and a cathode terminal infix in both sides on both sides of solid polyelectrolyte membrane is connected to series, While carrying out the temperature rise of the operating temperature of a cell stack linked to said series relatively [one by one] to a flow direction of said reactant gas in a fuel cell device which supplies reactant gas to series at a cell stack linked to these series, Said at least one or more cell stacks which carried out the temperature rise relatively one by one, It divides to a sub cell stack which carried out the temperature rise still more relatively [one by one] to a flow direction of said reactant gas, While humidifying said reactant gas beforehand and supplying it corresponding to an operating temperature of a sub cell stack passed first, a flow direction and a uniform direction of said reactant gas are equipped with a cooling-medium feeding means which pours a cooling medium in series.

[0027]To achieve the above objects, as indicated to claim 9, a fuel cell device concerning this invention, A cell stack which accumulated and constituted a unit cell provided with a separator which made an anode electrode and a cathode terminal infix in both sides on both sides of solid polyelectrolyte membrane is connected to series, In a fuel cell device which supplies reactant gas to series at a cell stack linked to these series, both sides of a reactant gas supply groove formed in said separator are equipped with a header.

[0028]To achieve the above objects, a fuel cell device concerning this invention equips a pars basilaris ossis occipitalis of a header with a manifold, as indicated to claim 10.

[0029]To achieve the above objects, as indicated to claim 11, a fuel cell device of this invention, A cell stack which accumulated and constituted a unit cell provided with a separator which made an anode electrode and a cathode terminal infix in both sides on both sides of solid polyelectrolyte membrane is connected to series, In a fuel cell device which supplies reactant gas to a cell stack linked to these series at series, it is characterized by comprising the following:

A means to make reactant gas supplied to said first cell stack humidify while carrying out the temperature rise of the operating temperature of a cell stack linked to said series relatively [, one by one] to a flow direction of said reactant gas.

A cooling-medium feed unit which makes a cell stack which was connected to said series and carried out the temperature rise relatively one by one circulate through a cooling medium.

A control system which drives a cooling-medium feed unit which makes a cell stack which was connected to said series and carried out the temperature rise relatively one by one circulate through a cooling medium.

[0030]To achieve the above objects, a fuel cell device concerning this invention constitutes a cooling-medium feed unit combining a condensator, a tank, and a circulating pump, as indicated to claim 12.

[0031]To achieve the above objects, as indicated to claim 13, a fuel cell device concerning this invention, A signal of either one of the dew-point temperature of a cell stack, and humidity which connected with series and carried out the temperature rise of the operating temperature to a control system relatively one by one in a flow direction of reactant gas, It calculates based on a vessel internal temperature degree signal of said electric stack, and has a control calculation part which drives or stops a cooling-medium feed unit which supplies a cooling medium to said cell stack.

[0032]To achieve the above objects, as indicated to claim 14, a fuel cell device concerning this invention, A signal of an internal resistance value of a unit cell which constitutes a cell stack which connected with series and carried out the temperature rise of the operating temperature to a control system relatively [one by one] to a flow direction of reactant gas, It calculates based on a vessel internal temperature degree signal of said cell stack, and has a control calculation part which drives or stops a cooling-medium feed unit which supplies a cooling medium to said cell stack.

[0033]To achieve the above objects, as indicated to claim 15, a fuel cell device concerning this

invention, It calculates based on a current signal and a vessel internal temperature degree signal which are generated in a cell stack which connected with a humidity signal of reactant gas, and series, and carried out the temperature rise of the operating temperature to a control system relatively [one by one] to a flow direction of reactant gas, It has a control calculation part which drives or stops a cooling-medium feed unit which supplies a cooling medium to said cell stack.
[0034]
[Embodiment of the Invention]Hereafter, the embodiment of the fuel cell device concerning this invention is described using the numerals attached in the drawing and the figure.
[0035]Drawing 1 is a mimetic diagram showing a 1st embodiment of the fuel cell device concerning this invention.
[0036]The fuel cell device concerning this embodiment the plate-like unit cell (unit cell) 10 which makes a usable area 169-cm^2, for example, Use ten sheets, put in the perpendicular direction, constitute the cell stack 11, and the cell stack 11, For example, while dividing to the cell stack 11a for low-temperature operation, the cell stack 11b for moderate temperature operation, and the cell stack 11c for high temperature operations and electrically connecting, It has composition which passes fuel gas and oxidant gas continuously toward the cell stack 11c for high temperature operations from the cell stack 11a for low-temperature operation among the cell stacks 11a, 11b, and 11c for high temperature operations into each low one. In this embodiment, each operating temperature of the cell stacks 11a, 11b, and 11 for high temperature operations is set as 50 **, 60 **, and 65 ** into low, A steam is beforehand added and humidified into low to the fuel gas and oxidant gas which are supplied to the cell stacks 11a, 11b, and 11c for high temperature operations, and into low, humidity of above-mentioned reactant gas is made high so that the operating temperature of the cell stacks 11a, 11b, and 11c for high temperature operations may be balanced.
[0037]When reactant gas (both fuel gas and oxidant gas) flows toward the cell stack 11c for high temperature operations one by one from the cell stack 11a for low-temperature operation, Since the diffusion rate of as opposed to [a reaction consumption rate (capacity factor) is high at the upstream, and a reaction consumption rate is low at the downstream, and] the anode electrode side of reactant gas and the cathode terminal side becomes low, in this embodiment. The effective area product of the fuel gas supply groove of the downstream and an oxidizer supply groove (not shown [both]) is relatively made small compared with it of the upstream, and it has the composition of raising the rate of flow of reactant gas and making reaction efficiency equalizing. Both a fuel gas supply groove and an oxidant gas supply groove make a pitch the same, and, specifically, have formed the depth ratio in 4:3:1 into low to the cell stacks 11a, 11b, and 11c for high temperature operations.
[0038]At this embodiment provided with such composition, as a result of being test operation, as for 400 mA/cm^2 and the reaction consumption rate (capacity factor) of fuel gas, 80%, the reaction consumption rate (capacity factor) of oxidant gas became 50%, and cell output operation time of load current density improved in 3000 hours compared with the former.
[0039]In this embodiment, since the cell stack 11 was divided into low to the cell stacks 11a, 11b, and 11c for high temperature operations, Compared with one cell stack which sets an operating temperature constant, average voltage increased 5% like before, and generating the stable cell output with little variation distribution moreover was accepted.
[0040]Thus, in this embodiment, the cell stack 11 is divided into low to each of the cell stacks 11a, 11b, and 11c for high temperature operations, Since reactant gas was made the composition passed from the cell stack 11a for low-temperature operation to continuation toward the cell stack 11c for high temperature operations one by one while carrying out the series connection of the cell stacks 11a, 11b, and 11c for high temperature operations electrically into low [which was divided], The stable cell output can be generated and the reaction consumption rate (capacity factor) of reactant gas can be raised further.
[0041]Namely, into low, to the cell stacks 11a, 11b, and 11c for high temperature operations, one by one, since reactant gas is passed to continuation, For example, even if the unreacted part of reactant gas

increases comparatively in the cell stack 11a for low-temperature operation, it can be made to be able to react by the next object for moderate temperature operation or the cell stacks 11b and 11c for high temperature operations, and can be made to consume without the place which leaves reactant gas.
[0042]In this embodiment, since the effective area product of the fuel gas supply groove of the downstream and the oxidant gas supply groove was relatively made small compared with it of the upstream and the rate of flow of reactant gas was raised, equalization of reaction efficiency can be attained and the stable cell output can be generated.
[0043]Therefore, since the cell output stable even if it did not supply reactant gas to each of the cell stacks 11a, 11b, and 11c for high temperature operations superfluously into low can be promoted according to this embodiment, the amount of supply of reactant gas can be lessened compared with the former.
[0044]In this embodiment, since each operating temperature of the cell stacks 11a, 11b, and 11c for high temperature operations was made high one by one in accordance with the flow of reactant gas into low, Since it will be made to evaporate in the object for moderate temperature operation or the cell stacks 11b and 11c for high temperature operations of order with a high operating temperature even if the water of condensation generated increases in number in the case of the reaction of the oxidant gas by the side of the carbon electrodes of the cell stack 11a for low-temperature operation, oxidant gas can be made to react good. Into low, although it may install separately [each of the cell stacks 11a, 11b, and 11c for high temperature operations] independently, since a specific cell stack has possibility of a fault cell output when it installs separately independently, it is preferred to carry out a series connection electrically.
[0045]Drawing 2 is a mimetic diagram showing a 2nd embodiment of the fuel cell device concerning this invention. Identical codes are given to the portion which is the same as the component part of a 1st embodiment, or corresponds.
[0046]The fuel cell device concerning this embodiment like a 1st embodiment the cell stack 11, For example, while dividing into low to the cell stacks 11a, 1b, and 11c for high temperature operations and carrying out the series connection of the cell stacks 11a, 11b, and 11c for high temperature operations electrically into low, The cooling-medium feeding means 12 which supplies a cooling medium, for example, cooling water, succeeding the cell stacks 11a, 11b, and 11c for high temperature operations, for example, cooling water piping, is established into low. The operating temperature of the cell stack 11a for low-temperature operation is determined by the temperature of the cooling medium supplied from the cooling-medium feeding means 12. The operating temperature of the cell stack 11c for high temperature operations measures the temperature of the cooling medium discharged from the cell stack 11c for high temperature operations, and is determined by adjusting the amount of cooling media. The mean temperature of the operating temperature of the cell stack 11a for low-temperature operation and the operating temperature of the cell stack 11c for high temperature operations is used for the operating temperature of the cell stack 11b for moderate temperature operation.
[0047]Thus, in this embodiment, the cooling-medium feeding means 12 which continues and supplies a cooling medium to the cell stacks 11a, 11b, and 11c for high temperature operations is established into low, Since much more temperature inclination-ization of the cell stacks 11a, 11b, and 11c for high temperature operations was attained into low, When making oxidant gas react temporarily by the cathode terminal side of the cell stack 11a for low-temperature operation, Even if the water of condensation generated increases in number, promotion of evaporation can be made to be able to ensure by the next object for moderate temperature operation or the cell stacks 11b and 11c for high temperature operations, and the cell output which raised much more reaction of oxidant gas and was stabilized can be generated.
[0048]Drawing 3 is a mimetic diagram showing a 3rd embodiment of the fuel cell device concerning this invention. Identical codes are given to the portion which is the same as the component part of a 1st embodiment, or corresponds.
[0049]The inside of low [which showed the fuel cell device concerning this embodiment by a 1st embodiment], inside, and the cell stacks 11a, 11b, and 11c for high temperature operations, While

dividing further the cell stack 11a for low-temperature operation into low to each of sub cell stack $11a_1$ for high temperature operations, $11a_2$, and $11a_3$, The flow direction and uniform direction of reactant gas (both fuel gas and oxidant gas) are made to carry out the series connection of sub cell stack $11a_1$ for high temperature operations, $11a_2$, and the $11a_3$ into low. Inside the cell stacks 11b and 11c for high temperature operations like ****, It is divided by sub cell stack $11b_1$ for low-temperature operation, $11c_1$, sub cell stack $11b_2$ for moderate temperature operation, $11c_2$, sub cell stack $11b_3$ for high temperature operations, and $11c_3$.

[0050]Generally, the cell stack 11 has cell output density in the tendency which becomes high to the thing compared with the outlet side in which the reaction consumption rate (capacity factor) of reactant gas is [the entrance side] lower, when the independent cell 10 is taken for an example.

[0051]In this embodiment, are what noted such a point, and into low to every cell stack 11a and 11b for high temperature operations, and 11c. It divides finely into low to sub cell stack $11a_1$ for high temperature operations, $11b_1$, $11c_1$, $11a_2$, $11b_2$, $11c_2$, and --.

[0052]Low [which was divided into low in this embodiment to every cell stack 11a and 11b for high temperature operations, and 11c], Inside, The fuel gas supply groove which supplies reactant gas (both fuel gas and oxidant gas) to sub cell stack $11a_1$ for high temperature operations, $11b_1$, $11c_1$, $11a_2$, $11b_2$, $11c_2$, and --. And compared with the upstream, the downstream is relatively made small for the effective area product of an oxidant gas supply groove (not shown [both]), and it has the composition of raising the fluid of reactant gas and making reaction efficiency equalizing. Like a 1st embodiment, make a pitch the same and specifically [both] the depth ratio, It has formed in 4:3:1 into low to sub cell stack $11a_1$ for high temperature operations, $11b_1$, $11c_1$, $11a_2$, $11b_2$, $11c_2$, and --.

[0053]Thus, in this embodiment into low to every cell stack 11a and 11b for high temperature operations, and 11c. Since it divided finely into low with sub cell stack $11a_1$ for high temperature operations, $11b_1$, $11c_1$, $11a_2$, $11b_2$, $11c_2$, and --, The stable cell output without the unevenness from the cell stacks 11a, 11b, and 11c for high temperature operations can be generated into low.

[0054]In this embodiment, into low to every cell stack 11a and 11b for high temperature operations, and 11c. Since it divided finely into low with sub cell stack $11a_1$ for high temperature operations, $11b_1$, $11c_1$, $11a_2$, $11b_2$, $11c_2$, and --, In the case of the reaction of oxidant gas, the water of condensation generated can be evaporated further and the reaction of oxidant gas can be promoted good.

[0055]In this embodiment, since the effective area product of the fuel gas supply groove of the downstream and the oxidant gas supply groove was relatively made small compared with it of the upstream and the rate of flow of reactant gas was raised, much more equalization of reaction high rate can be attained, and the stable cell output can be generated.

[0056]Drawing 4 is a mimetic diagram showing a 4th embodiment of the fuel cell device concerning this invention. Identical codes are given to the component part, the identical parts, or the corresponding portion of a 1st embodiment.

[0057]Like a 1st embodiment, while dividing the fuel cell device concerning this embodiment, for example into low to the cell stacks 11a, 11b, and 11c for high temperature operations, the cell stack 11, The reactant gas currently supplied to the cell stacks 11b and 11c for high temperature operations is made inside the composition which supplies an opposite direction one by one from the cell stack 11a for low-temperature operation after the operation-time progress which was able to be defined beforehand. The valve (not shown) installed in piping is specifically changed, and it is carried out by passing reactant gas to the flow direction and opposite direction of a graphic display. The operating method passed to an opposite direction is applied also to a 3rd embodiment shown by drawing 3 after the operation-time progress which was able to define reactant gas beforehand.

[0058]Thus, in this embodiment, since reactant gas was made the composition passed to an opposite direction after the operation-time progress which was able to be defined beforehand, the fall of the battery characteristic of the cell stacks 11a, 11b, and 11c for high temperature operations can be low suppressed into low, and generating of the stable cell output can be maintained for a long time.
[0059]Drawing 5 is a mimetic diagram showing a 5th embodiment of the fuel cell device concerning this invention. Identical codes are given to the portion which is the same as the component part of a 1st embodiment, a 2nd embodiment, and a 3rd embodiment, or corresponds.
[0060]The fuel cell device concerning this embodiment is what combined a 2nd embodiment and a 3rd embodiment with a 1st embodiment, Into low, to every cell stack 11a and 11b for high temperature operations, and 11c Low, inside, While dividing sub cell stack $11a_1$ for high temperature operations, $11b_1$, $11c_1$, $11a_2$, $11b_2$, $11c_2$, and --, the cooling feeding means 12 which pours a cooling medium is formed in the flow direction and uniform direction of reactant gas.
[0061]In this embodiment, thus, low, inside, Establish sub cell stack $11a_1$ for high temperature operations, $11b_1$, $11c_1$, $11a_2$, $11b_2$, $11c_2$, and the cooling-medium feeding means 12 of -- that continues and supplies a cooling medium to the flow direction and uniform direction of reactant gas, and Low, inside, Since sub cell stack $11a_1$ for high temperature operations, $11b_1$, $11c_1$, $11a_2$, $11b_2$, $11c_2$, and much more temperature inclination-ization of -- were attained, Evaporation of the water of condensation of each sub cell stack $11a_1$, $11b_1$, $11c_1$, $11a_2$, $11b_2$, $11c_2$, and -- generated by the carbon-electrodes side can be promoted further, and the stable cell output can be generated.
[0062]Drawing 6 is a schematic diagram showing the embodiment of the separator applied to the fuel cell device concerning this invention.
[0063]While the separator 13 concerning this embodiment forms two or more reactant gas supply grooves 14 which supply reactant gas in accordance with the perpendicular direction, The entrance head 15 provided with the inlet manifold 15a and the exit header 16 provided with the outlet manifolds 16a are formed in the both ends of the reactant gas supply groove 14.
[0064]Thus, in this embodiment, since the inlet header 15 and the exit header 16 are formed in the both ends of the reactant gas supply groove 14 of the separator 13 and more reactant gas is supplied to them, a still higher cell output can be generated compared with the former.
[0065]In this embodiment, since the both ends of the reactant gas supply groove 14 were equipped with the inlet header 15 and the exit header 16, More water of condensation generated from reactant gas can be processed, and without making the structure of the reactant gas supply groove 14, and shape complicate like before, the production man day time can be lessened and it can contribute to cost reduction. Since this embodiment equips the pars-basilaris-ossis-occipitalis side of the inlet header 15 and the exit header 16 with the manifolds 15a and 16a of the entrance and the exit, it can change the feeding-and-discarding exit of reactant gas freely.
[0066]Drawing 7 is an outline control system figure showing the embodiment which controls the operating temperature of the cell stack applied to the fuel cell device concerning this invention. Identical codes are given to the component part and identical parts of a 1st embodiment.
[0067]The cell stack 11 concerning this embodiment has the composition of having made into 30 sheets the plate-like unit cell (unit cell) 10 which makes a usable area 169-cm^2, for example, and having accumulated it in the perpendicular direction.
[0068]This cell stack 11 is provided with the humidifiers 17a and 17b which make that entrance side humidify fuel gas and oxidant gas, and the dew point recorder 18 which measures the humidity of oxidant gas to that outlet side. A hygrometer may be sufficient as the dew point recorder 18.
[0069]In order that the cell stack 11 may adjust the operating temperature in the vessel, It has composition provided with the cooling-medium feed unit 22 which combined the condensator 19, the tank 20, and the circulating pump 21 which supply a cooling medium, for example, cooling water, and the control calculation part 23 which gives a control signal to the condensator 19 and the circulating pump 21.

[0070]When the operating temperature in a vessel is set, for example as 80 ** now in the cell stack 11 provided with such composition, When the temperature which the operating temperature in a vessel measured with the dew point recorder 18 rather than 80 ** in the circumference of lower becomes 78 ** or less, the control calculation part 23, It calculates based on the operating temperature in a vessel, and the measurement temperature of the dew point recorder 18, the operation signal is given to the condensator 19 and the circulating pump 21, and the condensator 19 and the circulating pump 21 are made to drive. When it becomes higher than the operation operating temperature in a vessel, the control calculation part 23 gives the operation signal to the condensator 19 and the circulating pump 21, and stops the drive of the condensator 19 and the circulating pump 21.
[0071]thus -- forming the cooling-medium feed unit 22 and the control calculation part 23 in the cell stack 11 in this embodiment -- vessel inside installation -- a law -- to an operating temperature at the time of lower ******. Since evaporation of the water of condensation generated within a vessel was promoted when the water of condensation generated within a vessel was promoted, on the contrary it exceeded to the setting-out operating temperature in a vessel, the cell output generated from the cell stack 11 can be further heightened compared with the former. Incidentally, according to the experiment, sag speed was able to be made low 1/3 or less compared with the conventional operating-temperature regularity.
[0072]Drawing 8 is a control system figure showing the 1st modification of the embodiment shown in drawing 7 that controls the operating temperature of the cell stack applied to the fuel cell device concerning this invention.
[0073]While making it the same as that of the composition of the embodiment shown by drawing 7 in this example, Attach the measure resistance device 24 which measures the internal resistance of the unit cell 10 to the cell stack 11, it is made to calculate in the control calculation part 23 based on the resistance signal from the measure resistance device 24, and a vessel internal temperature degree signal, and is made to drive the cooling-medium feed unit 22.
[0074]When the measure resistance device 24 sets the operating temperature in a vessel, for example as 80 **, If the internal resistance value of the unit cell 10 becomes for example, more than 90-ohmcm^2, If the cooling-medium feed unit 22 is made to drive, the operating temperature of the cell stack 11 is reduced and it becomes below 90-ohmcm^2 conversely, the drive of the cooling-medium feed unit 22 is stopped, and it has composition which raises the operating temperature of the cell stack 11.
[0075]Therefore, according to this example, the cell output of the water of condensation generated in a vessel generated from the cell stack 11 since the operating temperature of the cell stack 11 is somewhat controllable according to quantity can be further heightened compared with the former.
[0076]Although the measure resistance device 24 was attached to the cell stack 11 in this example, Load current 25 [a total of] may be attached to the cell stack 11, it may be made to calculate in the control calculation part 23 based on the current signal from load current 25 [a total of], the signal from the humidifiers 17a and 17b, and the vessel internal temperature degree signal from the thermometer 26, and the cooling-medium feed unit 22 may be made to drive, as shown in drawing 9.
[0077]
[Effect of the Invention]The fuel cell device concerning this invention as the above explanation, While carrying out the temperature rise of the operating temperature of the cell stack which connected the cell stack to series and was connected to series relatively [one by one] to the flow direction of reactant gas, Since reactant gas is beforehand humidified corresponding to the operating temperature of the cell stack passed first, the reaction consumption rate of reactant gas can be raised and the stable cell output can be generated.
[0078]While carrying out the temperature rise of the operating temperature of the cell stack which the fuel cell device concerning this invention connected the cell stack to series, and was connected to series relatively [one by one] to the flow direction of reactant gas, Since the flow direction and uniform direction of reactant gas were equipped with the cooling-medium feeding means which pours a cooling medium and temperature inclination-ization of each cell stack was attained while making reactant gas

humidify beforehand corresponding to the operating temperature of the cell stack passed first, The cell output which promoted evaporation of the water of condensation generated and was stabilized can be generated in the case of the reaction of oxidant gas.

[0079]While carrying out the temperature rise of the operating temperature of the cell stack which the fuel cell device concerning this invention connected the cell stack to series, and was connected to series relatively [one by one] to the flow direction of reactant gas, While dividing at least one or more cell stacks which carried out the temperature rise relatively one by one to the sub cell stack which carried out the temperature rise still more relatively [one by one] to the flow direction of reactant gas, Since reactant gas is beforehand humidified corresponding to the operating temperature of the sub cell stack passed first, the reaction consumption rate of reactant gas can be raised further, and the stable cell output can be generated.

[0080]While carrying out the temperature rise of the operating temperature of the cell stack which the fuel cell device concerning this invention connected the cell stack to series, and was connected to series relatively [one by one] to the flow direction of reactant gas, Since the reactant gas passed to the cell stack which carried out the temperature rise was made the composition which can be passed in any direction of right reverse, generating of the stable cell output can be maintained for a long time.

[0081]Since the fuel cell device concerning this invention was made the composition which provides a header in the both ends of a separate reactant gas supply groove, and can supply more reactant gas, it can generate a still higher cell output under the structure made to simplify.

[0082]Since the fuel cell device concerning this invention established the control system which controls the cooling-medium feed unit which adjusts the operating temperature of a cell stack, and a cooling-medium feed unit, it can be adjusted to the desirable amount of water which made the water of condensation generated by the cell stack correspond to operational status.

[Translation done.]

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TECHNICAL FIELD

[Field of the Invention]This invention relates to the fuel cell device using the solid polymer membrane provided with ion conductivity as an electrolyte.

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PRIOR ART

[Description of the Prior Art]There is a thing of some form in a fuel cell device according to an electrolytic kind. In respect of the solid polymer electrolytic type fuel cell device using the solid polymer membrane provided with ion conductor nature as an electrolyte having high power density, and being able to make structure compact comparatively also in these, etc., it is observed these days and there are some which are shown in drawing 10 as the composition.
[0003]While this solid polyelectrolyte type fuel cell device constitutes the unit cell (unit cell) 4 which equipped both sides with the anode electrode (fuel electrode) 2 and the cathode terminal (oxidizing agent pole) 3 on both sides of the solid polyelectrolyte membrane 1 arranged in that center, It has the fuel gas supply groove 5a and the oxidant gas supply groove 5b which divide into each electrodes 2 and 3 and supply each of oxygen in fuel gas, for example, hydrogen, and oxidant gas, for example, air, via 6a and 7a, and has the composition of having excelled in conductivity and having formed the impermeable separators 6 and 7.
[0004]The anode electrode 2 is formed with the anode catalyst layer 2a and anode porous carbon monotonous 2b.
On the other hand, the cathode terminal 3 is formed with the cathode catalyst bed 3a and the cathode porous carbon plate 3b.

[0005]In the solid polyelectrolyte type fuel cell device provided with such composition, if fuel gas is supplied to the anode electrode 2 side and oxidant gas is supplied to the cathode terminal 3 side, the chemical reaction of the unit cell 4 will be carried out, and it will generate current. That is, if fuel gas is supplied to the anode electrode 2 side, while passing the hydrogen ion which was made to divide fuel gas into a hydrogen ion and an electron, and was separated to the solid polymer membrane 1, the anode catalyst layer 2a will pour an electron to an external circuit (not shown), and will generate current.
[0006]If oxidant gas is supplied to the cathode terminal 3 side, the cathode catalyst bed 3a will make the electron from the above-mentioned hydrogen ion and external circuit from the solid polyelectrolyte membrane 1 react to oxidant gas, especially oxygen, and will generate the water of condensation. In that case, the chemical equation by the side of the anode electrode 2 and the cathode terminal 3 is expressed with a following formula, respectively.
[0007]
[Formula 1]

アノード電極側 : $H_2 \rightarrow 2H^+ + 2e^-$

カソード電極側 : $2H^+ + \frac{1}{2} O_2 + 2e^- \rightarrow H_2O$

[0008]The water of condensation generated by the cathode terminal 3 side is emitted out of a vessel from the unit cell 4 with a unconverted gas.
[0009]Thus, although the unit cell 4 makes fuel gas and oxidant gas react and is generating

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EFFECT OF THE INVENTION

[Effect of the Invention]The fuel cell device concerning this invention as the above explanation, While carrying out the temperature rise of the operating temperature of the cell stack which connected the cell stack to series and was connected to series relatively [one by one] to the flow direction of reactant gas, Since reactant gas is beforehand humidified corresponding to the operating temperature of the cell stack passed first, the reaction consumption rate of reactant gas can be raised and the stable cell output can be generated.
[0078]While carrying out the temperature rise of the operating temperature of the cell stack which the fuel cell device concerning this invention connected the cell stack to series, and was connected to series relatively [one by one] to the flow direction of reactant gas, reactant gas is made to humidify beforehand corresponding to the operating temperature of the cell stack passed first.
Since the flow direction and uniform direction of reactant gas were equipped with the cooling-medium feeding means which pours a cooling medium on the other hand and temperature inclination-ization of each cell stack was attained, the cell output which promoted evaporation of the water of condensation generated and was stabilized can be generated in the case of the reaction of oxidant gas.

electromotive force, since the electromotive force to generate is less than 1V, usually it makes the unit cell 4 tens - 100 numbers, accumulates it in the perpendicular direction, and constitutes the cell stack 8 from a solid polyelectrolyte type fuel cell device.

[0010]The park RUORORO carbon sulfonic acid (trade name: Nafion, the U.S. Du Pont make) which, on the other hand, produces the solid polyelectrolyte membrane 1 applied as an electrolyte, for example to proton exchange membrane is used. This solid polyelectrolyte membrane 1 has an exchange group of a hydrogen ion in a molecule, and has a function good as ion conductivity by holding saturated water.

[0011]By the way, in order to generate the still higher electromotive force from the cell stack 8 and to secure good ion conductivity conjointly with development of the solid polymer membrane 1, making saturated water always hold is needed for the solid polyelectrolyte membrane 1. If the water of condensation generated by the cathode terminal 3 side is neglected as it is, since the reaction of the cathode terminal 3 will worsen, removal of the water of condensation is needed.

[0012]In order to make saturated water always hold to the solid polyelectrolyte membrane 1, If the steam near operational status is beforehand added to reactant gas (both fuel gas and oxidant gas) and is humidified, even if easily solvable, that structure is also complicated helps a means to remove the water of condensation generated at the cathode terminal 3 side, and development is difficult and is groping for it now.

[Translation done.]

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TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention]These days as a means to remove the water of condensation generated at the cathode terminal 3 side, Form the fuel gas supply groove 5a and the oxidant gas supply groove 5b of the separators 6 and 7 which supply reactant gas in the shape of Serpentine, or, The effective area product of the fuel gas supply groove 5a and the oxidant gas supply groove 5b is made small, a gas flow rate is raised, and the invention which blows away the water of condensation besides a vessel using the velocity energy is released (U.S. patent USP-4,988,583, USP-5,108,849).
[0014]However, in order to raise a gas flow rate, when the effective area product of the fuel gas supply groove 5a of the separators 6 and 7 and the oxidant gas supply groove 5b was made small, the number of each slots 5a and 5b increased further, the production man day also increased, and there was a problem that the cost which produces the cell stack 8 became much more expensive.
[0015]The water of condensation collected in each of that slot 5a and 5b when the effective area product of the fuel gas supply groove 5a of the separators 6 and 7 and the oxidant gas supply groove 5b was made small, Even if it could blow away besides the vessel, the water of condensation generated by the cathode catalyst bed 3a needed to be again put back to each of those slots 5a and 5b via the cathode porous carbon plate 3b, and there was a problem that the water of condensation was certainly unremovable only by raising a gas flow rate.
[0016]In order to blow away besides a vessel the water of condensation brought together in the fuel gas supply groove 5a and the oxidant gas supply groove 5b, Reactant gas needed to be high-voltage-ized, only the part which made reactant gas high-voltage-ize consumed many energies, and there were fault, such as becoming a factor which reduces plant thermal efficiency rather, and inconvenience on a sankey diagram as a result.
[0017]When the fuel gas supply groove 5a and the oxidant gas supply groove 5b were formed in the shape of Serpentine, there was a problem that the pressure loss of reactant gas made increase and consequential more much reactant gas consume.
[0018]An object of this invention is to provide the fuel cell device which coped with such a problem, was made, made the water of condensation generated by the cathode terminal side remove certainly, promoted the reaction of fuel gas and oxidant gas further, and attained high cell output-ization.

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MEANS

[Means for Solving the Problem]To achieve the above objects, as indicated to claim 1, a fuel cell device concerning this invention, A cell stack which accumulated and constituted a unit cell provided with a separator which made an anode electrode and a cathode terminal infix in both sides on both sides of solid polyelectrolyte membrane is connected to series, While carrying out the temperature rise of the operating temperature of a cell stack linked to said series relatively [one by one] to a flow direction of said reactant gas in a fuel cell device which supplies reactant gas to series at a cell stack linked to these series, Corresponding to an operating temperature of a cell stack passed first, said reactant gas is humidified beforehand and supplied.
[0020]To achieve the above objects, as indicated to claim 2, a fuel cell device concerning this invention, A cell stack which accumulated and constituted a unit cell provided with a separator which made an anode electrode and a cathode terminal infix in both sides on both sides of solid polyelectrolyte membrane is connected to series, While carrying out the temperature rise of the operating temperature of a cell stack linked to said series relatively [one by one] to a flow direction of said reactant gas in a fuel cell device which supplies reactant gas to series at a cell stack linked to these series, While humidifying said reactant gas beforehand and supplying it corresponding to an operating temperature of a cell stack passed first, a flow direction and a uniform direction of said reactant gas are equipped with a cooling-medium feeding means which pours a cooling medium.
[0021]To achieve the above objects, a fuel cell device concerning this invention divides a cell stack linked to series one by one along a flow direction of reactant gas to each cell stack an object for low-temperature operation, for moderate temperature operation, and for high temperature operations, as indicated to claim 3.
[0022]To achieve the above objects, as indicated to claim 4, a fuel cell device concerning this invention, A cell stack which accumulated and constituted a unit cell provided with a separator which made an anode electrode and a cathode terminal infix in both sides on both sides of solid polyelectrolyte membrane is connected to series, While carrying out the temperature rise of the operating temperature of a cell stack linked to said series relatively [one by one] to a flow direction of said reactant gas in a fuel cell device which supplies reactant gas to series at a cell stack linked to these series, While dividing said at least one or more cell stacks which carried out the temperature rise relatively one by one to a sub cell stack which carried out the temperature rise still more relatively [one by one] to a flow direction of said reactant gas, corresponding to an operating temperature of a sub cell stack passed first, said reactant gas is humidified beforehand and supplied.
[0023]To achieve the above objects, as indicated to claim 5, a fuel cell device concerning this invention, A sub cell stack which divided at least one or more cell stacks is divided one by one along a flow direction of reactant gas to an object for low-temperature operation, an object for moderate temperature operation, and each sub cell stack for high temperature operations.
[0024]To achieve the above objects, a fuel cell device concerning this invention forms relatively small an effective area product of the downstream of a reactant gas supply groove formed in a separator compared with an effective area product of the upstream of said reactant gas supply groove, as indicated

to claim 6.
[0025]To achieve the above objects, as indicated to claim 7, a fuel cell device concerning this invention, A cell stack which accumulated and constituted a unit cell provided with a separator which made an anode electrode and a cathode terminal infix in both sides on both sides of solid polyelectrolyte membrane is connected to series, While carrying out the temperature rise of the operating temperature of a cell stack linked to said series relatively [one by one] to a flow direction of said reactant gas in a fuel cell device which supplies reactant gas to series at a cell stack linked to these series, While humidifying said reactant gas beforehand and supplying it corresponding to an operating temperature of a cell stack passed first, it has a means which flows through said reactant gas passed to said cell stack which carried out the temperature rise relatively one by one in any direction for Masakata and of an opposite direction.

[0026]To achieve the above objects, as indicated to claim 8, a fuel cell device concerning this invention, A cell stack which accumulated and constituted a unit cell provided with a separator which made an anode electrode and a cathode terminal infix in both sides on both sides of solid polyelectrolyte membrane is connected to series, While carrying out the temperature rise of the operating temperature of a cell stack linked to said series relatively [one by one] to a flow direction of said reactant gas in a fuel cell device which supplies reactant gas to series at a cell stack linked to these series, Said at least one or more cell stacks which carried out the temperature rise relatively one by one, It divides to a sub cell stack which carried out the temperature rise still more relatively [one by one] to a flow direction of said reactant gas, While humidifying said reactant gas beforehand and supplying it corresponding to an operating temperature of a sub cell stack passed first, a flow direction and a uniform direction of said reactant gas are equipped with a cooling-medium feeding means which pours a cooling medium in series.
[0027]To achieve the above objects, as indicated to claim 9, a fuel cell device concerning this invention, A cell stack which accumulated and constituted a unit cell provided with a separator which made an anode electrode and a cathode terminal infix in both sides on both sides of solid polyelectrolyte membrane is connected to series, In a fuel cell device which supplies reactant gas to series at a cell stack linked to these series, both sides of a reactant gas supply groove formed in said separator are equipped with a header.
[0028]To achieve the above objects, a fuel cell device concerning this invention equips a pars basilaris ossis occipitalis of a header with a manifold, as indicated to claim 10.
[0029]To achieve the above objects, as indicated to claim 11, a fuel cell device of this invention, A cell stack which accumulated and constituted a unit cell provided with a separator which made an anode electrode and a cathode terminal infix in both sides on both sides of solid polyelectrolyte membrane is connected to series, In a fuel cell device which supplies reactant gas to a cell stack linked to these series at series, it is characterized by comprising the following:
A means to make reactant gas supplied to said first cell stack humidify while carrying out the temperature rise of the operating temperature of a cell stack linked to said series relatively [, one by one] to a flow direction of said reactant gas.
A cooling-medium feed unit which makes a cell stack which was connected to said series and carried out the temperature rise relatively one by one circulate through a cooling medium.
A control system which drives a cooling-medium feed unit which makes a cell stack which was connected to said series and carried out the temperature rise relatively one by one circulate through a cooling medium.

[0030]To achieve the above objects, a fuel cell device concerning this invention constitutes a cooling-medium feed unit combining a condensator, a tank, and a circulating pump, as indicated to claim 12.
[0031]To achieve the above objects, as indicated to claim 13, a fuel cell device concerning this invention, A signal of either one of the dew-point temperature of a cell stack, and humidity which connected with series and carried out the temperature rise of the operating temperature to a control system relatively one by one in a flow direction of reactant gas, It calculates based on a vessel internal

temperature degree signal of said electric stack, and has a control calculation part which drives or stops a cooling-medium feed unit which supplies a cooling medium to said cell stack.

[0032]To achieve the above objects, as indicated to claim 14, a fuel cell device concerning this invention, A signal of an internal resistance value of a unit cell which constitutes a cell stack which connected with series and carried out the temperature rise of the operating temperature to a control system relatively [one by one] to a flow direction of reactant gas, It calculates based on a vessel internal temperature degree signal of said cell stack, and has a control calculation part which drives or stops a cooling-medium feed unit which supplies a cooling medium to said cell stack.

[0033]To achieve the above objects, as indicated to claim 15, a fuel cell device concerning this invention, It calculates based on a current signal and a vessel internal temperature degree signal which are generated in a cell stack which connected with a humidity signal of reactant gas, and series, and carried out the temperature rise of the operating temperature to a control system relatively [one by one] to a flow direction of reactant gas, It has a control calculation part which drives or stops a cooling-medium feed unit which supplies a cooling medium to said cell stack.

[0034]

[Embodiment of the Invention]Hereafter, the embodiment of the fuel cell device concerning this invention is described using the numerals attached in the drawing and the figure.

[0035]Drawing 1 is a mimetic diagram showing a 1st embodiment of the fuel cell device concerning this invention.

[0036]The fuel cell device concerning this embodiment the plate-like unit cell (unit cell) 10 which makes a usable area 169-cm^2, for example, Use ten sheets, put in the perpendicular direction, constitute the cell stack 11, and the cell stack 11, For example, while dividing to the cell stack 11a for low-temperature operation, the cell stack 11b for moderate temperature operation, and the cell stack 11c for high temperature operations and electrically connecting, It has composition which passes fuel gas and oxidant gas continuously toward the cell stack 11c for high temperature operations from the cell stack 11a for low-temperature operation among the cell stacks 11a, 11b, and 11c for high temperature operations into each low one. In this embodiment, each operating temperature of the cell stacks 11a, 11b, and 11 for high temperature operations is set as 50 **, 60 **, and 65 ** into low, A steam is beforehand added and humidified into low to the fuel gas and oxidant gas which are supplied to the cell stacks 11a, 11b, and 11c for high temperature operations, and into low, humidity of above-mentioned reactant gas is made high so that the operating temperature of the cell stacks 11a, 11b, and 11c for high temperature operations may be balanced.

[0037]When reactant gas (both fuel gas and oxidant gas) flows toward the cell stack 11c for high temperature operations one by one from the cell stack 11a for low-temperature operation, Since the diffusion rate of as opposed to [a reaction consumption rate (capacity factor) is high at the upstream, and a reaction consumption rate is low at the downstream, and] the anode electrode side of reactant gas and the cathode terminal side becomes low, in this embodiment. The effective area product of the fuel gas supply groove of the downstream and an oxidizer supply groove (not shown [both]) is relatively made small compared with it of the upstream, and it has the composition of raising the rate of flow of reactant gas and making reaction efficiency equalizing. Both a fuel gas supply groove and an oxidant gas supply groove make a pitch the same, and, specifically, have formed the depth ratio in 4:3:1 into low to the cell stacks 11a, 11b, and 11c for high temperature operations.

[0038]At this embodiment provided with such composition, as a result of being test operation, as for 400 mA/cm^2 and the reaction consumption rate (capacity factor) of fuel gas, 80%, the reaction consumption rate (capacity factor) of oxidant gas became 50%, and cell output operation time of load current density improved in 3000 hours compared with the former.

[0039]In this embodiment, since the cell stack 11 was divided into low to the cell stacks 11a, 11b, and 11c for high temperature operations, Compared with one cell stack which sets an operating temperature constant, average voltage increased 5% like before, and generating the stable cell output with little variation distribution moreover was accepted.

[0040]Thus, in this embodiment, the cell stack 11 is divided into low to each of the cell stacks 11a, 11b, and 11c for high temperature operations, Since reactant gas was made the composition passed from the cell stack 11a for low-temperature operation to continuation toward the cell stack 11c for high temperature operations one by one while carrying out the series connection of the cell stacks 11a, 11b, and 11c for high temperature operations electrically into low [which was divided], The stable cell output can be generated and the reaction consumption rate (capacity factor) of reactant gas can be raised further.
[0041]Namely, into low, to the cell stacks 11a, 11b, and 11c for high temperature operations, one by one, since reactant gas is passed to continuation, For example, even if the unreacted part of reactant gas increases comparatively in the cell stack 11a for low-temperature operation, it can be made to be able to react by the next object for moderate temperature operation or the cell stacks 11b and 11c for high temperature operations, and can be made to consume without the place which leaves reactant gas.
[0042]In this embodiment, since the effective area product of the fuel gas supply groove of the downstream and the oxidant gas supply groove was relatively made small compared with it of the upstream and the rate of flow of reactant gas was raised, equalization of reaction efficiency can be attained and the stable cell output can be generated.
[0043]Therefore, since the cell output stable even if it did not supply reactant gas to each of the cell stacks 11a, 11b, and 11c for high temperature operations superfluously into low can be promoted according to this embodiment, the amount of supply of reactant gas can be lessened compared with the former.
[0044]In this embodiment, since each operating temperature of the cell stacks 11a, 11b, and 11c for high temperature operations was made high one by one in accordance with the flow of reactant gas into low, Since it will be made to evaporate in the object for moderate temperature operation or the cell stacks 11b and 11c for high temperature operations of order with a high operating temperature even if the water of condensation generated increases in number in the case of the reaction of the oxidant gas by the side of the carbon electrodes of the cell stack 11a for low-temperature operation, oxidant gas can be made to react good. Into low, although it may install separately [each of the cell stacks 11a, 11b, and 11c for high temperature operations] independently, since a specific cell stack has possibility of a fault cell output when it installs separately independently, it is preferred to carry out a series connection electrically.
[0045]Drawing 2 is a mimetic diagram showing a 2nd embodiment of the fuel cell device concerning this invention. Identical codes are given to the portion which is the same as the component part of a 1st embodiment, or corresponds.
[0046]The fuel cell device concerning this embodiment like a 1st embodiment the cell stack 11, For example, while dividing into low to the cell stacks 11a, 1b, and 11c for high temperature operations and carrying out the series connection of the cell stacks 11a, 11b, and 11c for high temperature operations electrically into low, The cooling-medium feeding means 12 which supplies a cooling medium, for example, cooling water, succeeding the cell stacks 11a, 11b, and 11c for high temperature operations, for example, cooling water piping, is established into low. The operating temperature of the cell stack 11a for low-temperature operation is determined by the temperature of the cooling medium supplied from the cooling-medium feeding means 12. The operating temperature of the cell stack 11c for high temperature operations measures the temperature of the cooling medium discharged from the cell stack 11c for high temperature operations, and is determined by adjusting the amount of cooling media. The mean temperature of the operating temperature of the cell stack 11a for low-temperature operation and the operating temperature of the cell stack 11c for high temperature operations is used for the operating temperature of the cell stack 11b for moderate temperature operation.
[0047]Thus, in this embodiment, the cooling-medium feeding means 12 which continues and supplies a cooling medium to the cell stacks 11a, 11b, and 11c for high temperature operations is established into low, Since much more temperature inclination-ization of the cell stacks 11a, 11b, and 11c for high temperature operations was attained into low, When making oxidant gas react temporarily by the cathode terminal side of the cell stack 11a for low-temperature operation, Even if the water of

condensation generated increases in number, promotion of evaporation can be made to be able to ensure by the next object for moderate temperature operation or the cell stacks 11b and 11c for high temperature operations, and the cell output which raised much more reaction of oxidant gas and was stabilized can be generated.
[0048]Drawing 3 is a mimetic diagram showing a 3rd embodiment of the fuel cell device concerning this invention. Identical codes are given to the portion which is the same as the component part of a 1st embodiment, or corresponds.
[0049]The inside of low [which showed the fuel cell device concerning this embodiment by a 1st embodiment], inside, and the cell stacks 11a, 11b, and 11c for high temperature operations, While dividing further the cell stack 11a for low-temperature operation into low to each of sub cell stack $11a_1$ for high temperature operations, $11a_2$, and $11a_3$, The flow direction and uniform direction of reactant gas (both fuel gas and oxidant gas) are made to carry out the series connection of sub cell stack $11a_1$ for high temperature operations, $11a_2$, and the $11a_3$ into low. Inside the cell stacks 11b and 11c for high temperature operations like ****, It is divided by sub cell stack $11b_1$ for low-temperature operation, $11c_1$, sub cell stack $11b_2$ for moderate temperature operation, $11c_2$, sub cell stack $11b_3$ for high temperature operations, and $11c_3$.
[0050]Generally, the cell stack 11 has cell output density in the tendency which becomes high to the thing compared with the outlet side in which the reaction consumption rate (capacity factor) of reactant gas is [the entrance side] lower, when the independent cell 10 is taken for an example.
[0051]In this embodiment, are what noted such a point, and into low to every cell stack 11a and 11b for high temperature operations, and 11c. It divides finely into low to sub cell stack $11a_1$ for high temperature operations, $11b_1$, $11c_1$, $11a_2$, $11b_2$, $11c_2$, and --.
[0052]Low [which was divided into low in this embodiment to every cell stack 11a and 11b for high temperature operations, and 11c], Inside, The fuel gas supply groove which supplies reactant gas (both fuel gas and oxidant gas) to sub cell stack $11a_1$ for high temperature operations, $11b_1$, $11c_1$, $11a_2$, $11b_2$, $11c_2$, and --. And compared with the upstream, the downstream is relatively made small for the effective area product of an oxidant gas supply groove (not shown [both]), and it has the composition of raising the fluid of reactant gas and making reaction efficiency equalizing. Like a 1st embodiment, make a pitch the same and specifically [both] the depth ratio, It has formed in 4:3:1 into low to sub cell stack $11a_1$ for high temperature operations, $11b_1$, $11c_1$, $11a_2$, $11b_2$, $11c_2$, and --.
[0053]Thus, in this embodiment into low to every cell stack 11a and 11b for high temperature operations, and 11c. Since it divided finely into low with sub cell stack $11a_1$ for high temperature operations, $11b_1$, $11c_1$, $11a_2$, $11b_2$, $11c_2$, and --, The stable cell output without the unevenness from the cell stacks 11a, 11b, and 11c for high temperature operations can be generated into low.
[0054]In this embodiment, into low to every cell stack 11a and 11b for high temperature operations, and 11c. Since it divided finely into low with sub cell stack $11a_1$ for high temperature operations, $11b_1$, $11c_1$, $11a_2$, $11b_2$, $11c_2$, and --, In the case of the reaction of oxidant gas, the water of condensation generated can be evaporated further and the reaction of oxidant gas can be promoted good.
[0055]In this embodiment, since the effective area product of the fuel gas supply groove of the downstream and the oxidant gas supply groove was relatively made small compared with it of the upstream and the rate of flow of reactant gas was raised, much more equalization of reaction high rate can be attained, and the stable cell output can be generated.
[0056]Drawing 4 is a mimetic diagram showing a 4th embodiment of the fuel cell device concerning this invention. Identical codes are given to the component part, the identical parts, or the corresponding portion of a 1st embodiment.

[0057]Like a 1st embodiment, while dividing the fuel cell device concerning this embodiment, for example into low to the cell stacks 11a, 11b, and 11c for high temperature operations, the cell stack 11, The reactant gas currently supplied to the cell stacks 11b and 11c for high temperature operations is made inside the composition which supplies an opposite direction one by one from the cell stack 11a for low-temperature operation after the operation-time progress which was able to be defined beforehand. The valve (not shown) installed in piping is specifically changed, and it is carried out by passing reactant gas to the flow direction and opposite direction of a graphic display. The operating method passed to an opposite direction is applied also to a 3rd embodiment shown by drawing 3 after the operation-time progress which was able to define reactant gas beforehand.
[0058]Thus, in this embodiment, since reactant gas was made the composition passed to an opposite direction after the operation-time progress which was able to be defined beforehand, the fall of the battery characteristic of the cell stacks 11a, 11b, and 11c for high temperature operations can be low suppressed into low, and generating of the stable cell output can be maintained for a long time.
[0059]Drawing 5 is a mimetic diagram showing a 5th embodiment of the fuel cell device concerning this invention. Identical codes are given to the portion which is the same as the component part of a 1st embodiment, a 2nd embodiment, and a 3rd embodiment, or corresponds.
[0060]The fuel cell device concerning this embodiment is what combined a 2nd embodiment and a 3rd embodiment with a 1st embodiment, Into low, to every cell stack 11a and 11b for high temperature operations, and 11c Low, inside, While dividing sub cell stack $11a_1$ for high temperature operations, $11b_1$, $11c_1$, $11a_2$, $11b_2$, $11c_2$, and --, the cooling feeding means 12 which pours a cooling medium is formed in the flow direction and uniform direction of reactant gas.
[0061]In this embodiment, thus, low, inside, Establish sub cell stack $11a_1$ for high temperature operations, $11b_1$, $11c_1$, $11a_2$, $11b_2$, $11c_2$, and the cooling-medium feeding means 12 of -- that continues and supplies a cooling medium to the flow direction and uniform direction of reactant gas, and Low, inside, Since sub cell stack $11a_1$ for high temperature operations, $11b_1$, $11c_1$, $11a_2$, $11b_2$, $11c_2$, and much more temperature inclination-ization of -- were attained, Evaporation of the water of condensation of each sub cell stack $11a_1$, $11b_1$, $11c_1$, $11a_2$, $11b_2$, $11c_2$, and -- generated by the carbon-electrodes side can be promoted further, and the stable cell output can be generated.
[0062]Drawing 6 is a schematic diagram showing the embodiment of the separator applied to the fuel cell device concerning this invention.
[0063]While the separator 13 concerning this embodiment forms two or more reactant gas supply grooves 14 which supply reactant gas in accordance with the perpendicular direction, The entrance head 15 provided with the inlet manifold 15a and the exit header 16 provided with the outlet manifolds 16a are formed in the both ends of the reactant gas supply groove 14.
[0064]Thus, in this embodiment, since the inlet header 15 and the exit header 16 are formed in the both ends of the reactant gas supply groove 14 of the separator 13 and more reactant gas is supplied to them, a still higher cell output can be generated compared with the former.
[0065]In this embodiment, since the both ends of the reactant gas supply groove 14 were equipped with the inlet header 15 and the exit header 16, More water of condensation generated from reactant gas can be processed, and without making the structure of the reactant gas supply groove 14, and shape complicate like before, the production man day time can be lessened and it can contribute to cost reduction. Since this embodiment equips the pars-basilaris-ossis-occipitalis side of the inlet header 15 and the exit header 16 with the manifolds 15a and 16a of the entrance and the exit, it can change the feeding-and-discarding exit of reactant gas freely.
[0066]Drawing 7 is an outline control system figure showing the embodiment which controls the operating temperature of the cell stack applied to the fuel cell device concerning this invention. Identical codes are given to the component part and identical parts of a 1st embodiment.
[0067]The cell stack 11 concerning this embodiment has the composition of having made into 30 sheets the plate-like unit cell (unit cell) 10 which makes a usable area 169-cm^2, for example, and having

accumulated it in the perpendicular direction.
[0068]This cell stack 11 is provided with the humidifiers 17a and 17b which make that entrance side humidify fuel gas and oxidant gas, and the dew point recorder 18 which measures the humidity of oxidant gas to that outlet side. A hygrometer may be sufficient as the dew point recorder 18.
[0069]In order that the cell stack 11 may adjust the operating temperature in the vessel, It has composition provided with the cooling-medium feed unit 22 which combined the condensator 19, the tank 20, and the circulating pump 21 which supply a cooling medium, for example, cooling water, and the control calculation part 23 which gives a control signal to the condensator 19 and the circulating pump 21.
[0070]When the operating temperature in a vessel is set, for example as 80 ** now in the cell stack 11 provided with such composition, When the temperature which the operating temperature in a vessel measured with the dew point recorder 18 rather than 80 ** in the circumference of lower becomes 78 ** or less, the control calculation part 23, It calculates based on the operating temperature in a vessel, and the measurement temperature of the dew point recorder 18, the operation signal is given to the condensator 19 and the circulating pump 21, and the condensator 19 and the circulating pump 21 are made to drive. When it becomes higher than the operation operating temperature in a vessel, the control calculation part 23 gives the operation signal to the condensator 19 and the circulating pump 21, and stops the drive of the condensator 19 and the circulating pump 21.
[0071]thus -- forming the cooling-medium feed unit 22 and the control calculation part 23 in the cell stack 11 in this embodiment -- vessel inside installation -- a law -- to an operating temperature at the time of lower ******. Since evaporation of the water of condensation generated within a vessel was promoted when the water of condensation generated within a vessel was promoted, on the contrary it exceeded to the setting-out operating temperature in a vessel, the cell output generated from the cell stack 11 can be further heightened compared with the former. Incidentally, according to the experiment, sag speed was able to be made low 1/3 or less compared with the conventional operating-temperature regularity.
[0072]Drawing 8 is a control system figure showing the 1st modification of the embodiment shown in drawing 7 that controls the operating temperature of the cell stack applied to the fuel cell device concerning this invention.
[0073]While making it the same as that of the composition of the embodiment shown by drawing 7 in this example, Attach the measure resistance device 24 which measures the internal resistance of the unit cell 10 to the cell stack 11, it is made to calculate in the control calculation part 23 based on the resistance signal from the measure resistance device 24, and a vessel internal temperature degree signal, and is made to drive the cooling-medium feed unit 22.
[0074]When the measure resistance device 24 sets the operating temperature in a vessel, for example as 80 **, If the internal resistance value of the unit cell 10 becomes for example, more than 90-ohmcm^2, If the cooling-medium feed unit 22 is made to drive, the operating temperature of the cell stack 11 is reduced and it becomes below 90-ohmcm^2 conversely, the drive of the cooling-medium feed unit 22 is stopped, and it has composition which raises the operating temperature of the cell stack 11.
[0075]Therefore, according to this example, the cell output of the water of condensation generated in a vessel generated from the cell stack 11 since the operating temperature of the cell stack 11 is somewhat controllable according to quantity can be further heightened compared with the former.
[0076]Although the measure resistance device 24 was attached to the cell stack 11 in this example, Load current 25 [a total of] may be attached to the cell stack 11, it may be made to calculate in the control calculation part 23 based on the current signal from load current 25 [a total of], the signal from the humidifiers 17a and 17b, and the vessel internal temperature degree signal from the thermometer 26, and the cooling-medium feed unit 22 may be made to drive, as shown in drawing 9.

[Translation done.]

* NOTICES *

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1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1]The lineblock diagram showing a 1st embodiment of the fuel cell device concerning this invention.
[Drawing 2]The mimetic diagram showing a 2nd embodiment of the fuel cell device concerning this invention.
[Drawing 3]The mimetic diagram showing a 3rd embodiment of the fuel cell device concerning this invention.
[Drawing 4]The mimetic diagram showing a 4th embodiment of the fuel cell device concerning this invention.
[Drawing 5]The mimetic diagram showing a 5th embodiment of the fuel cell device concerning this invention.
[Drawing 6]The schematic diagram showing the embodiment of the separator applied to the fuel cell device concerning this invention.
[Drawing 7]The outline control system figure showing the embodiment which controls the operating temperature of the cell stack applied to the fuel cell device concerning this invention.
[Drawing 8]The outline control system figure showing the 1st modification in the embodiment which controls the operating temperature of the cell stack applied to the fuel cell device concerning this invention.
[Drawing 9]The outline control system figure showing the 2nd modification in the embodiment which controls the operating temperature of the cell stack applied to the fuel cell device concerning this invention.
[Drawing 10]The mimetic diagram showing the unit cell in the conventional fuel cell device.
[Description of Notations]
1 Solid polyelectrolyte membrane
2 Anode electrode
2a Anode catalyst layer
2b Anode porous carbon plate
3 Cathode terminal
3a Cathode catalyst bed
3b Cathode porous carbon plate
4 and 10 Unit cell
5a Fuel gas supply groove
5b Oxidant gas supply groove
6 and 7 Separator
6a and 7a Partition
8 Cell stack
10 Unit cell
11 Cell stack

11a The cell stack for low-temperature operation
$11a_1$, $11b_1$, the sub cell stack for $11c_1$ low-temperature operation
11b The cell stack for moderate temperature operation
$11a_2$, $11b_2$, the sub cell stack for $11c_2$ moderate temperature operation
11c The cell stack for high temperature operations
$11a_3$, $11b_3$, the sub cell stack for $11c_3$ high temperature operations
12 Cooling water supply means
13 Separator
14 Reactant gas supply groove
15 Inlet header
15a Inlet manifold
16 Exit header
16a Outlet manifolds
17a and 17b Humidifier
18 Dew point recorder
19 Condensator
20 Tank
21 Circulating pump
22 Cooling-medium feed unit
23 Control calculation part
24 Measure resistance device
25 Load current meter
26 Thermometer

[Translation done.]